ARETHA SIATTA NEWMAN

CONTENT ANALYSIS OF THE BIOLOGY CURRICULUM OF LIBERIA IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS

MASTER THESIS

2024

NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF EDUCATIONAL DEVELOPMENT AND INSTRUCTIONS

CONTENT ANALYSIS OF THE BIOLOGY CURRICULUM OF LIBERIA IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS

MSc. THESIS

ARETHA SIATTA NEWMAN

NICOSIA

JANUARY 2024

NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF EDUCATIONAL DEVELOPMENT AND INSTRUCTIONS

CONTENT ANALYSIS OF THE BIOLOGY CURRICULUM OF LIBERIA IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS

MSc THESIS

ARETHA SIATTA NEWMAN

SUPERVISOR
ASSIST. PROF. DR. FATMA MIRALAY

NICOSIA

JANUARY 2024

Approval

We certify that we have read the thesis submitted by ARETHA SIATTA NEWMAN Entitled **"CONTENT ANALYSIS OF THE BIOLOGY CURRICULUM OF LIBERIA IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS"** and that in our combined opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master Science in Educational Development and Instructions.

Examining Committee	Name-Surname	Signature
Head of the Committee:	Assoc. Prof. Dr. Mert BAŞTAŞ	.....
Committee Member	Assoc. Prof. Dr. İpek DANJU	.....
Supervisor:	Assist. Prof. Dr. Fatma MIRALAY	.....

Approved by the Head of the Department

..../..../2024

.....

Assoc. Prof. Dr Umut AKÇIL

Head of Department

Approved by the Institute of Graduate Studies

..../..../2024

.....

Prof. Dr. Kemal Hüsnü Can Başer

Head of the Institute

Declaration

I hereby declare that all information, documents, analysis, and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

ARETHA SIATTA NEWMAN

…../…../2024

Acknowledgments

To begin with, I would like to thank the Almighty God for his choicest blessings and favor throughout my life. I want to acknowledge the valuable and sincere contributions of my supervisor Assistant Professor Dr. Fatma Miralay. Appreciation goes to my brothers and sister and my dearest mother Ms. Betty G. Newman for their moral, and financial support. I am grateful to all my friends, and colleagues, in Cyprus and back home who have supported me throughout this journey. I love you all

ARETHA SIATTA NEWMAN

Abstract

CONTENT ANALYSIS OF THE BIOLOGY CURRICULUM OF LIBERIA IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS

ARETHA SIATTA NEWMAN

MSc. Department of Educational Development and Instructions

January 2024, 157 Pages

As the global community grapples with pressing environmental challenges, the need for a comprehensive and forward-looking education system becomes paramount. This abstract explores the integration of Sustainable Development Goals (SDGs) into biology curricula, aiming to foster a holistic understanding of ecological systems and empower students to contribute to sustainable solutions. Recognizing the intricate interplay between biological concepts and sustainable development, this study advocates for a curriculum that goes beyond traditional biology teachings to incorporate real-world applications and global perspectives.

This research conducts a comprehensive content analysis of the biology curriculum of Liberia, especially for grades 10, 11 and 12 focusing on its alignment with the United Nations Sustainable Development Goals (SDGs). The study employs a content analysis methodology to systematically examine the content, themes, and emphasis within the biology curriculum, aiming to identify the extent to which it incorporates and addresses key concepts related to sustainable development. The analysis considers the representation of topics such as biodiversity, climate change, conservation, and environmental sustainability, among others, to assess the curriculum's responsiveness to the global imperative of achieving the SDGs. The findings from this research provide insights into the current status of biology education in fostering awareness and understanding of sustainable development issues. This information is crucial for educators, policymakers, and curriculum developers seeking to enhance the role of biology education in preparing students to contribute meaningfully to sustainable development goals.

Key Words: Biology, Curriculum, Education, Environment Sustainable Development

ÖZET

ÖZET

LİBERYA BİYOLOJİ ÖĞRETİM PROGRAMININ SÜRDÜRÜLEBİLİR KALKINMA HEDEFLERİ AÇISINDAN ANALİZİ

Aretha Siatta Newman

Eğitim Programları ve Öğretim Ana Bilim Dalı

15 Ocak 2024

Toplumun acil çevresel zorluklar karşısında kapsamlı ve ileriye dönük bir eğitim sisteminin ihtiyacı öncelikli hale gelmektedir. Bu araştırma, sürdürülebilir kalkınma hedefleri (Sustainable Development Goals, SDG'ler) biyoloji öğretim programına entegre edilmesini, ekolojik sistemlerin bütünsel bir anlayışını teşvik etmeyi ve öğrencilerin sürdürülebilen çözümlere katkıda bulunmalarını hedeflemiştir. Biyolojik kavramlar ile sürdürülebilir kalkınma arasındaki karmaşık etkileşimi analiz eden bu çalışma, geleneksel biyoloji öğretilerini aşan ve gerçek dünyadaki uygulamaları ve küresel perspektifleri içeren bir program savunmayı temel almıştır.

Bu araştırma, özellikle ortaöğretim 10, 11 ve 12 sınıflar için Liberya'nın biyoloji öğretim program içeriğinin kapsamlı bir analizini yaparak, bunların Birleşmiş Milletler Sürdürülebilir Kalkınma Hedefleri ile uyumuna odaklanmaktadır. (SDGs). Çalışma, biyoloji öğretim program çeriğini, temalarını ve önemini sistematik olarak incelemek için bir içerik analiz metodolojisi kullanmış, sürdürülebilir kalkınma ile ilgili anahtar kavramları içeren ve ele aldığı ölçüde tanımlamayı amaçlamıştır. Analiz, biyolojik çeşitlilik, iklim değişikliği, koruma ve çevresel sürdürülebilirlik gibi konuların temsil edilmesini göz önünde bulundurarak, programın SDG'leri gerçekleştirmenin küresel zorunluluğuna göre nasıl tepki verdiğini değerlendirmiştir. Araştırmada elde edilen bulgular doğrultusunda, sürdürülebilir kalkınma sorunlarının farkındalığı ve anlayışını teşvik etmek için biyoloji eğitiminin bugünkü durumuna dair bilgi sağlanmıştır. Bu bilgi, öğrencileri sürdürülebilir kalkınma hedeflerine anlamlı katkıda bulunmak için hazırlamak için biyoloji eğitiminin rolünü artırmak isteyen eğitimciler, politikacılar ve müfredat geliştiricileri için önem taşımaktadır.

Anahtar Kelimeler: Biyoloji, Öğretim Ders Programı, Eğitim, Çevre Sürdürülebilir Kalkınma

Table of Content

List of Tables

List of Abbreviations

COVID: Corona Virus Disease

CSR: Corporate Social Responsibility

ESD: Education for Sustainable Development

MDG: Millennium Development Goals

SDGs: Sustainable Development Goals

STEM: Science, Technology, Engineering, and Mathematics

UN: United Nations

UNCED: United Nations Conference on Environment and Development

UNESCO: United Nations Educational, Scientific and Cultural Organization

CHAPTER I

Introduction

A nation's destiny is heavily influenced by its educational system, which acts as a strong engine for growth and development. In this light, the curriculum forms the bedrock of educational systems, determining the knowledge, skills, and values that students acquire during their formative years. There is a growing worldwide emphasis on sustainable development, leading countries to adjust their educational systems to match the UN Sustainable Development Goals (SDGs). This paper delves into a comprehensive content analysis of the Biology curriculum in Liberia, examining how it aligns with and contributes to the achievement of the SDGs (Chankseliani & McCowan, 2021).

Liberia, a West African nation with a rich biodiversity and a diverse ecological landscape, recognizes the imperative of nurturing environmentally conscious citizens capable of contributing to sustainable development. The Biology curriculum, as a fundamental component of Liberia's education system, is crucial for imparting knowledge related to the natural world, ecosystems, and the interdependence of living organisms. The aim of this content analysis is to examine how well the Liberian biology curriculum relates to the Sustainable Development Goals (SDGs). (Nussey & Rigon, 2019).

The Sustainable Development Goals, which were set by all UN member states in 2015, serve as a global initiative to eradicate poverty, safeguard the environment, and promote prosperity for everyone by 2030.The interrelated aims highlight the need of an interdisciplinary and comprehensive educational approach, where topics such as Biology are crucial in fostering a generation that comprehends and actively supports sustainable practices. The first section of this analysis will delve into the core components of the Biology curriculum in Liberia, exploring the key themes, topics, and learning objectives outlined in the syllabus. Understanding the foundational concepts and knowledge that students are expected to acquire lays the groundwork for evaluating the curriculum's alignment with sustainable development principles (Hogan & O'Flaherty, 2021).

The study will next evaluate the relationship between the social, economic, and environmental aspects of the SDGs and the biology curriculum. By examining how the curriculum addresses issues such as economic, social, and environment, we can ascertain the degree to which it

contributes to the broader agenda of sustainable development. Furthermore, the analysis will explore potential areas for improvement and integration of cross-cutting themes within the Biology curriculum. It will consider the inclusion of practical applications, case studies, and real-world examples that resonate with the local context, fostering a deeper understanding of the relevance of biological concepts to Liberia's sustainable development journey.

Background

The intricate relationship between humans and the environment is an age-old narrative that unfolds across the annals of history. The first sections of this narrative depict a peaceful cohabitation and equilibrium between human need and the environment, but the introduction of industry and modernity has altered the following sections with a more sinister and foreboding atmosphere. The narrative of environmental degradation is a testament to humanity's relentless pursuit of progress and development, often at the cost of the very ecosystems that sustain life on Earth. In pre-industrial societies, humans lived in close connection with nature, relying on the land for sustenance and recognizing the importance of preserving ecological equilibrium. Indigenous cultures, for instance, often harbored profound respect for the environment, viewing it not merely as a resource to exploit but as a partner in the delicate dance of survival. However, as civilizations evolved and technological advancements burgeoned, a paradigm shift occurred, laying the groundwork for an era where human actions would echo with far-reaching consequences (Scharlemann, Brock, Balfour, Brown, Burgess, Guth & Kapos, 2020).

The Industrial Revolution, occurring in the late 18th century, was a crucial turning point. The rapid mechanization of production processes, fueled by the burning of fossil fuels, ushered in unprecedented economic growth but also set the stage for widespread environmental disruption. Factories spewed pollutants into the air and rivers, causing negative externalities, transforming landscapes and poisoning ecosystems. As societies embraced the convenience of machinery and harnessed the power of coal and later oil, they inadvertently unleashed forces that would alter the very fabric of the global environment (Singh, R. L., & Singh, 2017).

The 20th century had a rapid growth in human population and consumption habits, which heightened the pressure on the Earth's limited resources. The period after World War II, marked by the increase in consumerism and mass manufacturing, witnessed an accelerated depletion of natural resources, air and water pollution, and deforestation. The widespread use of pesticides

and chemicals in agriculture promised bountiful harvests but also left an indelible mark on the environment, impacting ecosystems, ultimately, and human health. In the second half of the 20th century, there was an increasing awareness of the environmental impact of human activities. Concerns over air and water pollution, loss of biodiversity, and the looming specter of climate change began to permeate public discourse. The 1972 United Nations Conference on the Human Environment in Stockholm was a pivotal occasion in recognizing the need of worldwide collaboration to tackle environmental challenges (Sánchez et.al 2023).

However, despite growing awareness, the following decades witnessed an acceleration of environmental degradation, driven by a surge in industrialization, urbanization, and the voracious appetite for natural resources. The depletion of ozone, deforestation, and the acidification of oceans became stark reminders of the toll human actions were taking on the delicate balance of the planet's ecosystems. The 21st century emerged as a crucial juncture in the narrative of human-environment interactions. The global society faced the pressing need to address climate change by decreasing carbon emissions and shifting towards sustainable practices. Yet, the challenges persisted, with debates over economic interests, political will, and individual responsibility shaping the course of environmental policies worldwide (Teixeira, et al. 2023).

Considering the prevailing circumstances, it is evident that various challenges of a multifaceted nature, encompassing but not limited to issues like migration, conflicts, gender disparity, income inequality, and economic injustices, have become increasingly pronounced in recent times. These challenges, pervasive and escalating, underscore the imperative for a comprehensive reevaluation of our comprehension of development and the dynamics of our relationship with the environment.

In light of the aforementioned challenges, it is crucial to cultivate an approach that not only strives for equilibrium in the natural order but also seeks to foster concurrent progress in economic and social domains. There arises a pressing need for a novel and inclusive strategy that is poised to furnish equal opportunities and foster prosperity universally. This necessitates a paradigm shift in our developmental perspectives, aligning them with a vision that transcends conventional boundaries and emphasizes the creation of a societal framework where all individuals can flourish on equal footing (Davis & Elliott, 2023).

Education for Sustainable Development (ESD) stands at the forefront of global efforts to address the interconnected challenges of environmental conservation, social equity, and economic development. The idea of ESD arose in response to today's urgent problems—climate change, biodiversity loss, poverty, and inequality—by acknowledging the need for an all-encompassing and holistic strategy to education. It aims to provide people with the required information, knowledge, values, and attitudes to help build a more vibrant and resilient world. (Kopnina, 2020).

As societies grapple with the consequences of unsustainable practices and a changing climate, education becomes a powerful tool to foster a mindset shift and empower future generations to address these challenges. The United Nations (UN) has been a key proponent of integrating sustainability principles into educational systems worldwide, Recognizing the important impact education has on forming the beliefs and actions of people and communities. The United Nations, through various agencies and initiatives, has been actively promoting the incorporation of sustainable development into educational curricula at national and international levels The United Nations Decade of Education for Sustainable Development (2005-2014) intended to incorporate sustainability ideas into education policy and practices worldwide. (Nousheen, et al, 2020).

Adopted in 2015, the United Nations' Sustainable Development Goals (SDGs) aim to further emphasize the importance of education as a catalyst for achieving a sustainable future. Goal four specifically focuses on quality education in an effort to ensure that all people have access to high-quality education that encourages them to continue studying throughout their lives. Within this goal, there is a target (4.7) dedicated to ESD, advocating for the teaching of SDGs goals and the promotion of its values (Jeronen, 2020).

UNESCO, a specialized organization of the United Nations, has been at the forefront of these efforts. UNESCO's Global Action Program on Education for Sustainable Development (ESD), initiated in 2014, acts as a structure to expand ESD execution on a global scale. The program encourages countries to integrate sustainability into their educational policies, teacher training, and curricula. Moreover, The UNESCO ESD for 2030 roadmap highlights the need of providing learners with transformational education to empower them with the necessary knowledge and skills to support sustainable development. It encourages a shift towards participatory, learner-

centered approaches that promote critical thinking, creativity, and problem-solving (Cebrián, et. al, 2020).

At regional and national levels, the UN supports initiatives that promote ESD. Efforts made in collaboration with governments, non-governmental organizations, and educational institutions are aimed at developing curricula that are adapted to the specifics of the local environment and address challenges of global sustainability. Capacity-building programs for educators and the development of educational resources are integral components of these initiatives. With education having a wide global influence and the ability to affect different groups of people, Countries that have committed to conferences, declarations, and action plans must clearly outline their aims and strategies in the educational activities they carry out. This will help to promote faster progress. Liberia is included in the group of such countries. The National High School Biology Curriculum of Liberia is based on the belief that life science or biological science is crucial for understanding events in the universe. The purpose of this curriculum is to develop problem-solving abilities, enhance competence in scientific process skills, and highlight the significant impact of life science on areas such as social dynamics, economic paradigms, and technical landscapes. Moreover, it aims to cultivate the ability to draw perceptive conclusions on societal events associated with the use of various energy sources (Baena-Morales, S., & González-Víllora, 2023).

Problem Statement

Recently, there has been an increasing acknowledgment of the crucial role that education plays in promoting sustainable development, and national curricula are considered essential tools for shaping the knowledge, attitudes, and values of future generations. Liberia, like many other nations, has pledged to adhere to the United Nations Sustainable Development Goals (SDGs). It is essential to examine how educational curricula, especially in biology, assist to attaining sustainable development by integrating these aims across different sectors. (Wehye, 2023).

The biology curriculum in Liberia serves as a foundational platform for students to develop a comprehensive understanding of biological concepts and principles. However, the question arises as to whether this curriculum adequately reflects and aligns with the SDGs, which encompass a broad spectrum of environmental, social, and economic dimensions. A thorough content analysis of the biology curriculum is essential to discern the explicit and implicit connections between the

curriculum content and the goals outlined in the 2030 Agenda for Sustainable Development (Wehye, 2023).

Several critical issues prompt the need for such an investigation. Firstly, the effective implementation of the SDGs necessitates an educational system that empower students with the values and abilities to tackle multi-faceted problems including environmental degradation, epidemics, and public health crises. Thus, assessing the biology curriculum is crucial to determine its effectiveness in preparing students to make valuable contributions to sustainable development. Identifying gaps or disparities between the biology curriculum and the SDGs is essential for guiding curriculum development and reform efforts. Addressing these gaps will ensure that the curriculum not only meets current educational standards but also aligns with the country's commitment to achieving the SDGs. Furthermore, understanding the extent to which the curriculum incorporates interdisciplinary approaches and real-world applications of biological concepts in the context of sustainable development is paramount (Sisuse, 2023).

Thirdly, as the global community increasingly recognizes the interconnectedness of environmental, social, and economic issues, an analysis of the biology curriculum in Liberia provides an opportunity to explore the integration of cross-cutting themes, such as ethical considerations, social justice, and ecological sustainability. An investigation into whether these themes are adequately addressed within the curriculum can shed light on the curriculum's potential to instill a holistic understanding of biology among students.

In light of the above considerations, this research aims to conduct a comprehensive content analysis of the biology curriculum in Liberia emphasizing its compatibility with the United Nations Sustainable Development Goals. Through a systematic examination of curriculum documents, textbooks, and teaching materials, this study intends to identify the explicit and implicit connections between the biology curriculum and the SDGs. The findings will contribute valuable insights to educational policymakers, curriculum developers, and educators, facilitating informed decisions for the enhancement of the biology curriculum to better address the imperatives of sustainable development in Liberia.

Purpose of the Research

1. To analyze how well the current biology does curriculum in Liberia align with the objectives of the SDGs.
2. To examine what specific topics within the biology curriculum contribute directly to the promotion of sustainable development as outlined in the SDGs
3. Evaluate the degree to which the biology curriculum in Liberia integrates cross-disciplinary methods to tackle the environmental, social, and economic aspects emphasized in the SDGs.
4. To establish the gaps within the biology curriculum of Liberia that need enhancement to better address the SDGs

Research Questions

1. How well does the quality of the current biology curriculum in Liberia align with the objectives of the SDGs?
2. What specific topics within the biology curriculum contribute directly to the promotion of sustainable development as outlined in the SDGs?
3. Evaluate the degree to which the biology curriculum in Liberia integrates cross-disciplinary methods to tackle the environmental, social, and economic aspects emphasized in the SDGs.
4. Are there any gaps within the biology curriculum of Liberia that need enhancement to better address the SDGs, and if so, what are they?

Significance of the Study

The study on the "Content Analysis of the Biology Curriculum of Liberia in terms of Sustainable Development Goals (SDGs)" holds profound significance in the realm of education, environmental sustainability, and national development. This research aims to critically examine

the alignment between the existing biology curriculum in Liberia and the globally endorsed Exploring how biology education might contribute to sustainable development goals. The following points highlight the extensive significance of this study:

The Sustainable Development Goals (SDGs) are a collection of 17 interrelated global objectives established by United Nations member states to tackle a range of social issues such as poverty, inequality, climate change, environmental degradation, peace, and justice. By scrutinizing the alignment of Liberia's biology curriculum with these goals, this research adds to the global effort to achieve sustainable development. The findings of the study can directly inform educational policy in Liberia. If discrepancies between the biology curriculum and the SDGs are identified, policymakers can use this information to guide curriculum revisions.

Aligning the curriculum with the SDGs can enhance the educational system's responsiveness to the country's development needs, fostering a generation of environmentally conscious and socially responsible citizens.

By evaluating the biology curriculum, the study provides insights into the extent to which it equips students with the knowledge and skills necessary for addressing environmental challenges and promoting sustainable practices. This analysis can inform strategies to enhance the curriculum's effectiveness in building the capacity of students to contribute meaningfully to sustainable development initiatives. Sustainable development is inherently interdisciplinary, requiring a holistic understanding of environmental, social, and economic issues. This study examines how well the biology curriculum integrates interdisciplinary elements related to sustainable development. It sheds light on the potential for cross-disciplinary collaboration within the education system, promoting a more comprehensive approach to addressing complex challenges.

The project aims to increase awareness among educators, students, and communities about the significance of incorporating sustainable development ideas into biology teaching. It encourages dialogue on how biology, as a subject, can be a powerful tool for fostering environmental stewardship, biodiversity conservation, and responsible resource management within local communities. As nations strive to meet the demands of the 21st century, aligning educational curricula with global sustainability goals becomes crucial. This study positions Liberia within the global discourse on education for sustainable development, ensuring that its educational system

remains relevant and competitive on the international stage. A curriculum that effectively integrates sustainable development principles has the potential to influence generations of students. By fostering an understanding of ecological systems, biodiversity, and environmental responsibility the research helps cultivate a population that is more aware of the lasting impacts of human actions on the environment.

Lastly, the research design and methodology employed in this study could pave the way for similar analyses in other countries, fostering a comparative understanding of how different national biology curricula align with the SDGs. This can contribute to a broader dialogue on best practices for incorporating sustainability into science education globally.

Limitations of the Study

Conducting a content analysis of the biology curriculum of Liberia in terms of Sustainable Development Goals (SDGs) is a valuable endeavor, but like any research study, it comes with its set of limitations. The findings of the content analysis may be specific to Liberia's context, making it challenging to generalize the results to other countries with different educational systems, cultural backgrounds, and socio-economic contexts.

The study is time-sensitive, as curricula are subject to frequent revisions. Potentially influencing the applicability and reliability of the results are modifications to the biology curriculum that may have occurred after the research was carried out. The study focuses on the content of the biology curriculum, but the actual implementation of the curriculum in classrooms may vary. Differences in teaching methods, resources, and teacher training can impact the extent to which SDGs are effectively integrated into the learning experience.

Furthermore, SDGs are inherently interdisciplinary, involving various sectors such as economics, social sciences, and environmental studies. Focusing solely on the biology curriculum may overlook the interconnectedness of SDGs, limiting a comprehensive understanding of sustainability. The study did not incorporate the perspectives of more key stakeholders such as teachers, students, and policymakers. Had the research incorporated more education stakeholders other than a few their feedback might provide light on the prospects and obstacles of incorporating SDGs into biology curricula in a more concrete way. Limited resources, including time, funding, and access to relevant materials, limited the depth and breadth of the content

analysis. This has impacted the comprehensiveness of the study and its ability to capture the nuances of the curriculum. Lastly, SDGs are dynamic and evolving over time. New goals or changes in the prioritization of existing goals may occur, rendering the content analysis outdated or less relevant in the future.

Definition of Key Terms

Biology is the study of all things alive and how they relate to one another and their surroundings. Biology is the scientific study of life and all its facets, including anatomy, physiology, genetics, ecology, and taxonomy.

Competence: refers to the ability, skill, knowledge, or proficiency that enables a person to perform a particular task or job successfully. It encompasses a combination of understanding, aptitude, experience, and capability in a specific area or field.

Content analysis Text, audio, video, pictures, and other symbolic forms of communication may all be subject to content analysis, a study approach that methodically examines their contents.

Curriculum: refers to a structured and organized plan of study that outlines the content, skills, and learning experiences students are expected to acquire during a specific course, program, or educational journey. It serves as a guide for educators, outlining the sequence of topics, learning objectives, instructional methods, and assessments.

Education: is a process of acquiring knowledge, skills, values, and understanding through various formal and informal means.

Environment: relates to the environment or conditions in which a particular species, organism, or community of organisms resides.

Modernization: The introduction of machinery and automated processes to replace or enhance manual labor in manufacturing and other industries.

Sustainable Development Goals (SDGs): The Sustainable Development Goals (SDGs), which were created by the UN in 2015, are a group of seventeen global goals and an ambitious plan to address a variety of economic, social, and environmental challenges.

Sustainable Development "sustainable development" is a course of action that takes into accounts both current and future demands, ensuring that neither will be compromised.

Education for Sustainable Development: (ESD) The goal of the educational strategy known as "Education for Sustainable Development" (ESD) is to make sustainability a central tenet of every subject taught.

CHAPTER II

Literature Review

Sustainable Development's Evolution

There has been a gradual but steady rise in consciousness of the interconnected nature of economic, social, and environmental issues over the course of sustainable development's multi-decade history. When it became clear that conventional approaches to development often

resulted in resource exploitation, social inequality, and environmental damage, the idea of sustainable development evolved as a solution. The World Commission on Environment and Development first used the phrase "sustainable development" in their 1987 report "Our Common Future." (WCED), also known as the Brundtland Commission (Kirkby, O'Keefe & Timberlake, 2023).

Sustainable development was defined by the Brundtland Commission as progress that satisfies the requirements of the current generation while safeguarding the capacity of future generations to fulfill their own needs. This groundbreaking report served as a catalyst, bringing global attention to the pressing need for a paradigm shift in how societies approached development. It highlighted the connection between economic advancement, social fairness, and environmental preservation, paving the way for a more comprehensive and unified method of policy formulation. (Kirkby, O'Keefe & Timberlake, 2023).

The 1992 United Nations Conference on Environment and Development (UNCED), sometimes called the Earth Summit, significantly advanced the discussion on sustainable development. During this landmark event in Rio de Janeiro, world leaders adopted Agenda 21, an extensive strategy for attaining sustainable development in the 21st century. Agenda 21 included several topics such as poverty, consumer habits, biodiversity protection, and the involvement of women in sustainable development. (Caradonna, 2022).

The subsequent years witnessed an increasing recognition that sustainable development required not only international cooperation but also local and national initiatives. Governments, businesses, and civil society organizations began incorporating sustainability principles into their policies and practices. Corporate Social Responsibility (CSR) has become more important as firms recognize their need to ensure beneficial contributions to society and the environment. In the early 21st century, the Millennium Development Goals (MDGs) were introduced. They consisted of eight global development objectives aimed at eliminating poverty, attaining universal primary education, advancing gender equality, and fighting illnesses. The MDGs were praised for progress but faced criticism for not directly tackling environmental sustainability. The worldwide community introduced the Sustainable Development objectives (SDGs) in 2015. This framework includes 17 interrelated objectives that include economic, social, and environmental aspects of development. (Caradonna, 2022).

Parallel to these global initiatives, grassroots movements and environmental activism gained momentum, drawing attention to the urgent need for sustainable practices. Climate change, deforestation, and pollution have become key topics in discussions about sustainability, prompting governments and corporations to reassess their policies and practices. Technological breakthroughs and inventions have significantly contributed to increasing sustainability in recent years. Renewable energy sources, circular economy methods, and sustainable agricultural techniques are becoming essential elements of the changing environment Incorporating sustainability into business models is now seen as both a moral need and a strategic benefit in a society facing resource limitations and climatic issues. (Becker, 2023).

As we move forward, the evolution of sustainable development continues to be shaped by ongoing global challenges, such as the climate crisis, biodiversity loss, and social inequalities. There is a renewed desire and commitment from governments, corporations, and people globally to solve these concerns urgently. The evolution of sustainable development is an ongoing journey, one that requires collective action, innovation, and a fundamental shift in the way we conceive and pursue progress (Becker, 2023).

The Advent of Sustainable Development

The advent of the Sustainable Development Goals (SDGs) signifies a significant change in worldwide perspectives and efforts aimed at establishing a fair, enduring, and just global community. The origins of the SDGs may be traced to the early 21st century, when the global community saw the need for a thorough and all-encompassing framework to tackle the interrelated issues confronting mankind. The SDGs evolved from the MDGs, which were a collection of eight objectives created in 2000 to address issues including severe poverty, universal primary education, gender equality, and illnesses like HIV/AIDS and malaria. While the MDGs made significant strides in addressing some critical issues, it became evident that a more expansive and integrative approach was necessary to confront the complex and interrelated challenges of the modern world (Roorda, 2020).

As the 2015 deadline for the MDGs approached, the United Nations launched an extensive and inclusive consultation process involving governments, civil society, academia, and the private sector. This joint endeavor aimed to determine the main objectives and goals for a development plan beyond 2015. The Sustainable Development Goals were officially approved by all 193

United Nations member states at the UN Sustainable Development Summit in September 2015. From health, education, and gender equality to environmental sustainability, poverty, and hunger are just a few of the many topics covered by the 17 interrelated objectives and 169 targets that make up the SDGs. The SDGs are recognized as generally relevant, in contrast to the MDGs that mainly targeted poor nations. This is because global problems need global solutions. This inclusivity reflects a paradigm shift in understanding that sustainable development is a shared responsibility that transcends national borders there is no text provided. The SDGs are centered on the idea of ensuring that no one is excluded, highlighting the need of addressing the most vulnerable and disadvantaged groups. The aims include the economic, social, and environmental aspects of development, recognizing the complex relationship between poverty, inequality, and environmental harm. The holistic approach is summarized in the notion of sustainable development, aiming to fulfill current demands without jeopardizing the capacity of future generations to fulfill their own needs. (Ashby, 2022).

The 2030 Agenda for Sustainable Development, together with the SDGs, serves as a plan for significant change, urging nations to synchronize their national policies and goals with the main objective of establishing a more sustainable and inclusive world. Achieving the SDGs requires a collaborative and multi-stakeholder approach, involving governments, the private sector, civil society, and individuals alike. Since their introduction, the SDGs have served as a guiding framework for legislation, resource allocation, and collective action at the local, national, and global levels. Global governments and organizations are implementing strategies to include the Sustainable Development Goals (SDGs) into their development strategies and track advancements using specific indicators. Communities and people are fighting for change and demanding that leaders live up to their promises as a result of the SDGs. (Roosa, 2020).

Significant obstacles persist, notwithstanding the advancements achieved since the SDGs were adopted. The need for immediate and concerted effort is heightened by pressing global concerns including climate change, inequality, and the continuing effects of the COVID-19 epidemic. By calling on all nations to reassess their priorities and strive for a future without inequality, the SDGs bring people together under a common goal of making the world a better, more equitable place. The journey towards achieving the SDGs is ongoing, requiring sustained commitment, innovation, and collaboration to build a world that prioritizes the well-being of people and the planet (Roosa, 2020).

The Sustainable Development Goals

Goal 1.	End poverty in all its forms everywhere
Goal 2.	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3.	Ensure healthy lives and promote well-being for all at all ages
Goal 4.	Ensure inclusive and equitable quality education and promote live long learning opportunities for all
Goal 5.	Achieve gender quality and empower all women and girls
Goal 6.	Ensure availability and sustainable management of water and sanitation for all
Goal 7.	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8.	Promote sustained, inclusive and sustainable economic growth, full and productive employment decent work for all
Goal 9.	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10.	Reduce inequality within and among countries
Goal 11.	Make cities and human settlement inclusive, safe, resilient and sustainable
Goal 12.	Ensure sustainable consumptions and production pattern
Goal 13	Take urgent action to combat climax change and it's impacts
Goal 14.	Conserve and sustainably use the oceans, seas, and marine for sustainable development
Goal 15.	Protect restore, and promote sustainable use of terrestrial ecosystem, sustainably, manage forests, combat desertification, and halt and reserve land degradation and halt biodiversity loss
Goal 16.	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective accountable and inclusive institutions at all levels strengthen the means of implementation and revitalize the global partnership for sustainable development
Goal 17.	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Social Dimension of the Sustainable Development Goals

All throughout the world, people are still facing a wide variety of societal problems; the Sustainable Development Goals (SDGs) provide a thorough and lofty framework to try to solve these problems. As a set of goals for a more equitable and sustainable future, the SDGs were

adopted by all UN Member States in 2015 as part of the 2030 Agenda for Sustainable Development. At their core, the SDGs recognize that social progress is intricately linked to broader development goals, and thus, a comprehensive strategy that takes into account social, environmental, and economic factors is required to attain sustainable development. (Janker, J., & Mann, 2020).

The social components of the SDGs include a broad range of concerns including poverty, hunger, health, education, gender equality, clean water, sanitation, and social justice. These goals are not isolated objectives but are interrelated and interdependent, recognizing the complex web of factors that contribute to social well-being. The social aspects of the Sustainable Development Goals (SDGs) are essential for promoting inclusive, resilient, and fair societies in light of significant global issues including climate change, pandemics, and inequality. (Fuchs, 2021.

One of the cornerstone goals within the social dimensions of the SDGs is the eradication of poverty (Goal 1). Poverty is acknowledged as a significant obstacle to sustainable development in many aspects and extents. The SDGs aim to ensure that all people, regardless of their background or location, can enjoy a basic standard of living that includes access to food, shelter, and essential services. This aim recognizes that poverty is a complex problem affected by several causes such social exclusion, discrimination, and limited access to education and healthcare. (Ikram, Zhang & Ferasso, 2020).

Education (Goal 4) emerges as another pivotal aspect within the social dimensions, acknowledging the significant impact of education in disrupting the cycle of poverty and promoting long-lasting development. The significance of inclusive and high-quality education for all is emphasized by the SDGs, which advocate for opportunities for continuous learning that empower both communities and individuals. By addressing educational disparities and ensuring access to quality education, the SDGs aim to empower people with the values and knowledge needed to participate fully in society and contribute to sustainable development (Ikram, Zhang & Ferasso, 2020).

Gender equality (Goal 5) is a cross-cutting theme that permeates the social dimensions of the SDGs. Acknowledging the intrinsic worth of gender parity and the empowerment of every girl and woman, the Sustainable Development Goals (SDGs) endeavor to eradicate gender-based discrimination, violence, and detrimental behaviors. Achieving gender equality is not only a

fundamental human right but also a catalyst for social and economic progress. The social aspects of the SDGs advocate for the elimination of systemic obstacles that sustain gender disparity and the encouragement of women's proactive involvement in decision-making procedures throughout all industries. (Corsi, Pagani & Kovaleski, 2020).

Health (Goal 3) is another critical element within the social dimensions, highlighting the significance of providing healthcare services to all individuals. The SDGs aim to ensure healthy lives and promote well-being for all at all ages, recognizing that good health is a prerequisite for sustainable development. This objective incorporates the reduction of environmental hazards to health and the promotion of mental well-being, in addition to the prevention and treatment of diseases. (Corsi, Pagani & Kovaleski, 2020).

In essence, the social dimensions of the SDGs underscore the interconnectedness of various societal elements and the necessity for a sustainable, inclusive, and all-encompassing approach to development. By addressing poverty, education, gender equality, and health, among other key issues, In order to construct societies that are resilient and equitable enough to withstand the challenges of the twenty-first century, the SDGs serve as a road map. As the international community strives to achieve the SDGs by 2030, a collective commitment to addressing the social dimensions is paramount to creating a world where no one is left behind, and where sustainable development becomes a reality for all (Tsalis, Malamateniou, Koulouriotis & Nikolaou, 2020).

Economic Dimension of SDGs

In the wake of unprecedented global challenges, the international community has rallied around a transformative agenda designed to address the interconnected and complex issues facing our world The United Nations established the Sustainable Development Goals (SDGs) in 2015 with the intention of providing a comprehensive framework to promote sustainable development in various aspects, including the environment, society, and economy. While the SDGs encapsulate a holistic vision for a better future, this discussion will focus on the economic dimensions of the SDGs, recognizing the critical role that economic development plays in achieving broader sustainable objectives (Bali & Yang-Wallentin, 2020).

The economic dimensions of the SDGs underscore the imperative to create inclusive, resilient, and sustainable economies that benefit all citizens while safeguarding the planet. This ambitious agenda encompasses a wide spectrum of economic considerations, ranging from poverty eradication and inclusive growth to innovation, infrastructure development, and responsible consumption and production. At its core, the economic facet of the SDGs seeks to strike a delicate balance between promoting economic prosperity and safeguarding the well-being of current and future generations (Ruggerio, 2021).

One of the paramount challenges addressed by the economic dimensions of the SDGs is the eradication of poverty. SDG Goal 1 focuses on eradicating poverty in all its manifestations, acknowledging that economic prosperity is a crucial need for human progress. The economic aspect of poverty alleviation involves not only income generation but also access to basic services, education, healthcare, and opportunities for meaningful employment. As such, the economic dimensions of the SDGs are intricately interwoven with other goals, reinforcing the idea that sustainable development is a multidimensional endeavor (Lee, Noh & Khim, 2020).

In tandem with poverty eradication, the economic dimensions of the SDGs place a premium on fostering inclusive economic growth. Goal 8 specifically advocates for the advancement of continuous, comprehensive, and sustainable economic development, as well as ensuring full and productive employment and appropriate work opportunities for everyone. This goal recognizes that economic progress must be shared equitably, bridging social and economic inequalities. Promoting inclusivity in economic growth is both a moral need and a practical approach to attaining sustained stability and prosperity. (Lee, Noh & Khim, 2020).

In addition to inclusive growth, the economic dimensions of the SDGs underscore the importance of innovation and infrastructure development (Goals 9 and 11, respectively) as catalysts for economic transformation. Sustainable economic development relies on technological advancements, efficient infrastructure, and resilient urbanization. These components enhance economic productivity, promote environmental sustainability, and improve social well-being. Goal 12, responsible consumption and production, has a vital economic role in the SDGs. As the global population burgeons and consumption patterns intensify, the sustainability of economic activities becomes paramount. Goal 12 promotes sustainable resource usage, waste reduction, and the implementation of sustainable business strategies. By aligning

economic activities with environmental stewardship, this goal aims to mitigate the adverse impact of production and consumption on the planet (Alvino, Vaio, Hassan & Palladino, 2021).

In conclusion, the economic dimensions of the SDGs form the bedrock of a comprehensive and interconnected approach to global development. By addressing poverty, promoting inclusive growth, fostering innovation, investing in infrastructure, and advocating for responsible consumption and production, the SDGs envision a world where economic prosperity is harmoniously intertwined with social equity and environmental sustainability. The economic aspects of the Sustainable Development Goals (SDGs) provide guidance for countries in addressing the difficulties of the modern world and creating a future that is both financially robust and ecologically strong. (Alvino, Vaio, Hassan & Palladino, 2021).

Environmental Dimension SDGs

Striving for a sustainable and fair future, the international community has recognized the critical role of addressing environmental challenges. The United Nations has led the development of a comprehensive framework called the Sustainable Development Goals (SDGs) to steer worldwide endeavors towards a more stable and adaptable planet. Among the 17 interconnected goals established by the United Nations, several are specifically dedicated to environmental dimensions, reflecting the acknowledgement that environmental sustainability is not only intrinsic to ecological well-being but also pivotal for achieving broader development objectives (Fonseca, Domingues & Dima, 2020).

The environmental dimensions of the SDGs encapsulate a multifaceted approach to address pressing ecological issues, ranging from climate change and biodiversity loss to water scarcity and pollution. These dimensions underscore the intricate interdependence between environmental health, human well-being, and socioeconomic progress. As we delve into the environmental aspects of the SDGs, it becomes apparent that they are not isolated goals but integral components of a holistic strategy aimed at fostering harmony between humanity and the planet (Fonseca, Domingues & Dima, 2020).

One of the paramount environmental challenges highlighted within the SDGs is climate change, encapsulated in Goal 13: Climate Action. The need to reduce and adapt to climate change has been emphasized by increasing global temperatures, severe weather events, and disturbances to

ecosystems. Attaining the goals set in Goal 13 requires focused actions to decrease greenhouse gas emissions, improve resistance to climatic effects, and advocate for sustainable methods that support a low-carbon future. Biodiversity conservation is another pivotal aspect woven into the fabric of the SDGs, explicitly addressed in Goal 15: Life on Land and Goal 14: Life below Water The objectives acknowledge the complex interconnectedness of life that supports ecosystems and emphasize the need of conserving biodiversity for the well-being of present and future generations. Strategies outlined in these goals include the sustainable management of forests, the protection of marine ecosystems, and the promotion of responsible consumption and production patterns (Eisenmenger, Pichler, Krenmayr, Noll, Plank, Schalmann & Gingrich, 2020).

Water, a finite and essential resource, is a cross-cutting theme that finds its place in several SDGs, notably Goal 6: Ensure access to clean water and sanitation. Access to clean water is essential for human health and is crucial for agriculture, industry, and economic growth. The objectives set forth in Goal 6 encompass ensuring universal access to safe drinking water, improving water quality, and promoting efficient water use to address growing concerns about water scarcity and contamination. Addressing environmental dimensions also involves tackling pollution, as underscored in Goal 12: Responsible Consumption and Production. The excessive generation of waste, pollution of air and water, and unsustainable consumption patterns pose significant threats to the environment and human health. This goal calls for a paradigm shift towards sustainable practices, circular economies, and the responsible management of resources to decouple economic growth from environmental degradation (Zakari, Khan, Tan, Alvarado & Dagar, 2020).

Moreover, the environmental dimensions of the SDGs recognize the interconnectedness of all goals. For instance, achieving gender equality (Goal 5), eradicating poverty (Goal 1), and ensuring access to quality education (Goal 4) are intimately linked to environmental sustainability. Environmental degradation often exacerbates existing inequalities and disproportionately affects vulnerable populations, emphasizing the need for an integrated approach to development. In conclusion, the environmental dimensions of the SDGs provide a comprehensive roadmap for addressing the complex challenges facing our planet. By recognizing the interplay between environmental sustainability, social equity, and economic development, the SDGs offer a framework for transformative change. As we navigate the path towards a sustainable future, it is imperative to embrace the interconnected nature of these goals,

fostering collaborations and innovative solutions that transcend disciplinary boundaries and national borders. We can only establish a harmonic balance between human well-being and the health of the earth by a united and coordinated effort. (Mondejar, Avtar, Diaz, Dubey, Esteban, Gómez-Morales & Garcia-Segura, 2021).

Education for Sustainable Development

In an era marked by unprecedented global challenges such as climate change, biodiversity loss, and socio-economic inequalities, the role of education has evolved beyond traditional boundaries to encompass a broader, more profound purpose – that of sustainable development. Education for Sustainable Development (ESD) is a significant change in educational philosophy that focuses on preparing students with the information, skills, and attitudes needed to help create a more sustainable and resilient world. (Zhang, Shaikh, Yumashev & Chłąd, 2020).

At its core, Education for Sustainable Development aims to provide a comprehensive understanding of the complex relationships between ecological, social, and economic aspects of human life. Developed against the backdrop of growing concerns about the environmental degradation and the impact of unsustainable practices on the planet, ESD aims to empower learners to become active agents of positive change. It goes beyond traditional educational limits by including environmental, economic, and social aspects into learning experiences. The origins of ESD may be linked to the first talks on sustainable development at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. The Rio Earth Summit laid the foundation for a global commitment to sustainable development, culminating in the Agenda 21, a comprehensive action plan that highlighted the pivotal role of education in achieving sustainability goals. UNESCO played a significant role in promoting Education for Sustainable Development (ESD), seeing it as a crucial approach to tackling the issues of the 21st century.

One of the fundamental principles of ESD is its emphasis on interdisciplinary. Traditional educational approaches often compartmentalize knowledge into distinct disciplines, limiting learners' ability to grasp the interconnectedness of global challenges. ESD, on the other hand, encourages an integrative approach, fostering an understanding of the complex relationships between ecological, social, and economic systems. By embracing interdisciplinary learning, ESD

seeks to cultivate a holistic worldview among students, preparing them to confront multifaceted issues with innovative and collaborative solutions (Alam, 2021).

Furthermore, ESD is not confined to formal educational settings but extends its reach to informal and lifelong learning contexts. Recognizing that learning is a continuous process that occurs throughout one's life, ESD promotes a culture of curiosity and critical thinking, encouraging individuals to engage with sustainability issues beyond the confines of traditional classrooms. This inclusive approach aims to empower people of all ages and backgrounds to become informed and active participants in shaping a sustainable future. Moreover, the concept of Education for Sustainable Development is underpinned by the recognition that sustainable development cannot be achieved without a profound transformation in societal values and behaviors. ESD endeavors to instill ethical values, such as empathy, responsibility, and global citizenship, which are essential for fostering a sense of collective responsibility towards the well-being of the planet and its inhabitants. In doing so, it seeks to cultivate a new generation of environmentally conscious and socially responsible individuals who can contribute meaningfully to the global quest for sustainability (Burbules, Fan & Repp, 2020).

Education for Sustainable Development is an innovative approach to learning that goes beyond conventional educational models. As we stand at the crossroads of unprecedented global challenges, the transformative power of education becomes increasingly apparent. ESD emerges as a beacon of hope, illuminating a path towards a future where individuals are not only equipped with the knowledge and skills to thrive but also possess the wisdom and values to safeguard the planet for generations to come. This introduction merely scratches the surface of the multifaceted realm of Education for Sustainable Development, setting the stage for an in-depth exploration of its principles, practices, and potential impact on our collective journey towards a sustainable and resilient future (Burbules, Fan & Repp, 2020).

Conceptual Framework for Sustainable Development

The Conceptual Framework for Sustainable Development is a detailed and ongoing plan that supports worldwide endeavors to establish a peaceful equilibrium of economic success, social fairness, and environmental stewardship. Developed as a response to the increasingly interlinked challenges facing the world, this framework provides a structured approach to guide policies, strategies, and actions toward sustainable development goals. It embraces a holistic view that

acknowledges the complex interconnections among the economy, society, and the environment, with the goal of meeting current demands without jeopardizing the capacity of future generations to satisfy their own. (Cheng, Wang, Xiong, Zhu & Cheng, 2021).

Sustainable development, as articulated in this conceptual framework, is a dynamic and adaptive process that transcends traditional silos of thought and action. It acknowledges that the pursuit of economic growth must be intertwined with social inclusivity and environmental responsibility to ensure long-term viability. The framework encourages a departure from narrow, short-term objectives and emphasizes the importance of holistic, Progressive strategies that take into account the interconnectedness of economic, social, and environmental systems. The 1992 Rio Declaration on Environment and Development and the 2000 adoption of the Millennium Development Goals are two significant international accords that laid the groundwork for what is now known as the Conceptual Framework for Sustainable Development. These foundational documents set the stage for a paradigm shift, urging nations to recognize the inextricable linkages between poverty eradication, environmental conservation, and social progress. Over time, this conceptual framework has evolved to incorporate emerging challenges, including climate change, biodiversity loss, and social inequality, further emphasizing the need for integrated and transformative solutions ((Cheng, Wang, Xiong, Zhu & Cheng, 2021).

Recognizing that sustainability encompasses economic and social aspects in addition to environmental preservation is one of the framework's major elements. The Triple Bottom Line concept, popularized by sustainability advocate John Elkington, sums up the concept by stressing that organizations and enterprises should assess their success according to social and environmental metrics as well as financial ones. True sustainable development necessitates a harmony among economic expansion, social justice, and ecological preservation; this all-encompassing view is fundamental to the framework. Moreover, the Conceptual Framework for Sustainable Development promotes the idea that achieving sustainability requires collaborative and inclusive governance structures. Recognizing the interconnectedness of global challenges Governments, businesses, nonprofits, and academic institutions are all urged to work together in this document. The framework's goal, via these collaborations, is to promote the sharing of information, the development of new ideas, and the pooling of resources in order to tackle difficult problems that go beyond national borders. (Khan, Malik, Zafar, Goni, Chofreh, Klemeš & Alotaibi, 2020).

As the world grapples with pressing challenges such as climate change, loss of biodiversity, and social inequality, the relevance of the Conceptual Framework for Sustainable Development becomes increasingly pronounced. Politicians, companies, and communities may all look to it as a north star, a method to navigate the contemporary world's complexity while protecting present and future generations. In essence, this framework represents a commitment to a more sustainable, equitable, and resilient future—a future where economic, social, and environmental considerations are seamlessly woven into the fabric of global decision-making and action (de Vries, Donner & Axelos, 2021).

The Role of Biology Curriculum in Sustainable Development

The biology curriculum plays a crucial role in sustainable development by providing a basic framework for comprehending the complex interconnectedness of life and the delicate balance that supports our planet. A thorough and well-structured biology curriculum serves as both an educational resource and a driving force in preparing a future generation of environmentally aware persons in light of worldwide issues including climate change, biodiversity loss, and environmental degradation. At its core, biology is the study of life, encompassing the diversity of organisms, ecosystems, and the myriad interactions that define the natural world. In the pursuit of sustainable development Ecology has a varied role in understanding the intricacies of ecological systems, ecological interdependencies, and the consequences of human actions on the environment. The biology curriculum becomes a key instrument in equipping students with the knowledge and skills necessary to comprehend the intricate mechanisms governing life on Earth (Novidsa, Purwianingsih & Riandi, 2020).

Moreover, integrating sustainable development ideas into the biology curriculum is important not only for the classroom but also for larger social goals. By instilling a profound appreciation for the interconnectedness of living organisms and their environments, the curriculum lays the groundwork for fostering a sense of ecological responsibility among learners. Students, armed with a solid understanding of biological concepts, are better positioned to recognize the consequences of unsustainable practices and make informed decisions that contribute to the well-being of the planet (Bizimana, Mutangana & Mwesigye, 2021).

In a world grappling with the repercussions of anthropogenic activities, the biology curriculum becomes a powerful agent of change, steering educational paradigms towards a more holistic and

ecologically sensitive approach. It provides a lens through which students can critically analyze environmental issues, dissecting the root causes and contemplating viable solutions. As a result, the curriculum acts as a catalyst for the development of a generation that not only comprehends the ecological challenges facing the world but is also poised to actively engage in finding innovative and sustainable solutions. In essence, the role of the biology curriculum in sustainable development is one of profound significance, shaping the worldview of individuals and influencing their attitudes towards the environment. By delving into the intricacies of life sciences, students are not only equipped with the tools to understand the biological underpinnings of sustainability but are also inspired to become stewards of the planet. As we navigate an era marked by environmental uncertainty, the biology curriculum stands as an indispensable cornerstone in nurturing a generation capable of fostering harmony between human activities and the delicate ecosystems that sustain life on Earth (Dogan, 2021).

Education for Sustainable Development in Liberia

Liberia, a nation on the west coast of Africa, has embarked on a transformative journey in recent years, aiming to intertwine education with sustainable development as a catalyst for positive change. The history of Liberia, marked by periods of civil unrest and economic challenges, has underscored the critical importance of investing in education as a cornerstone for national progress. Education and sustainable development are highlighted as a key focus for policymakers, educators, and the broader community in this setting, aligning with the worldwide dedication to the United Nations Sustainable Development Goals. (SDGs) (Adebayo, 2022).

The Republic of Liberia, founded in the 19th century as a haven for freed slaves from the Americas, faced a protracted civil conflict that spanned more than a decade, leaving a legacy of social and economic disruption. As the nation strives to overcome the aftermath of these challenges, education has emerged as a potent force for fostering resilience, social cohesion, and sustainable development. Recognizing the intrinsic link between a well-educated populace and a thriving society, Liberia has undertaken concerted efforts to reform its education system, aligning it with the principles of sustainability and inclusivity (Adebayo, 2022).

The sustainable development agenda in Liberia encapsulates a multifaceted approach that addresses economic, social, and environmental dimensions. Education is a crucial element of this agenda and has a significant impact on determining the future path of the country. Liberia has

made great progress in improving education availability, quality, and creating an environment that supports overall growth in recent years. The global community's commitment to the SDGs has provided Liberia with a framework to integrate sustainable development into its educational landscape. Sustainable Development Goal 4 (SDG 4) places particular emphasis on the provision of quality education that is inclusive and equitable for all individuals. It emphasizes the profound impact that education can have in promoting sustainable development and disrupting the cycle of poverty. Liberia's educational initiatives, therefore, align with the global vision of leaving no one behind, as the nation works towards building a society where education serves as a vehicle for empowerment and societal advancement (Jappah & Smith, 2022).

This study investigates the relationship between education and sustainable development in Liberia. It analyzes policy interventions, challenges, successes, and the wider implications for national development across the country's educational landscape. From the rebuilding of educational infrastructure to the integration of sustainability principles in curriculum design, Liberia's journey reflects a commitment to harnessing the potential of education as a key driver of sustainable progress. While negotiating the complexities of Liberia's educational system in the sake of long-term sustainability, we uncover a narrative of resilience, hope, and the transformative power of knowledge in shaping a brighter, more sustainable future for this African nation (Kakupa, P., & Shayo, 2021).

Despite the strides made in incorporating sustainable development into Liberia's education system, challenges persist. Limited resources, infrastructure deficits, and the need for teacher training pose hurdles to the widespread implementation of ESD. However, these challenges are met with an unwavering determination to overcome them. International collaborations, community engagement, and innovative teaching methods are identified as potential avenues to address these obstacles and transform them into opportunities for growth (Kakupa & Shayo, 2021).

Education for Sustainable Development in Biology

In the 21st century, humanity faces unprecedented challenges, from climate change and biodiversity loss to global health crises. In the pursuit of a sustainable future, there is an urgent need to redefine the way we approach education, particularly in the realm of Biology. Education for Sustainable Development (ESD) is a pedagogical paradigm that recognizes the

interconnection of ecological, social, and economic systems, aiming to bring about transformation. Biology education is crucial for developing a profound understanding of the natural world, promoting ecological literacy, and cultivating responsible citizenship. (Shutaleva, Nikonova, Savchenko & Martyushev, 2020).

Biology, as a discipline, offers a unique lens through which students can explore the intricate web of life on Earth. It goes beyond mere factual knowledge, encouraging learners to appreciate the dynamic relationships between organisms, ecosystems, and the environment. Integrating ESD concepts into Biology teaching enables students to understand the tremendous influence of human actions on the earth while also providing them with the information and skills required to handle difficult environmental concerns. One important feature of ESD in biology teaching is developing a systems-thinking approach. Traditional Biology curricula often compartmentalize topics into isolated categories, neglecting the interconnectedness of biological processes. ESD seeks to bridge these gaps, emphasizing the importance of understanding ecosystems as holistic entities where every component, from microorganisms to microorganisms, plays a crucial role. By embracing a systems-thinking perspective, students can grasp the delicate balance of nature and recognize their role as stewards of biodiversity (Taimur & Sattar, 2020).

Furthermore, ESD promotes problem-solving and critical thinking in biology education. Students must be able to analyze complex issues, evaluate evidence, and propose innovative solutions in a world that is undergoing rapid change. Biology, as a dynamic and evolving field, offers an ideal platform for cultivating these skills. ESD fosters inquiry-based learning, enabling students to explore real-world problems, engage in hands-on experiments, and collaborate on projects that address local and global sustainability issues. The integration of ethical considerations is another cornerstone of ESD in Biology education. As students delve into the intricacies of genetic engineering, biotechnology, and ecological restoration, they are confronted with ethical dilemmas that require thoughtful reflection. ESD encourages educators to facilitate discussions on the ethical implications of scientific advancements, promoting a sense of responsibility and ethical decision-making among students. By instilling a strong ethical foundation, Biology education becomes a driving force for creating environmentally conscious and socially responsible citizens (Sund & Gericke, 2020).

Fundamentally, Education for Sustainable Development in Biology transcends the mere transmission of information. It is a holistic approach that aims to inspire a profound shift in attitudes, values, and behaviors. Through fostering ecological literacy, promoting systems thinking, cultivating critical skills, and integrating ethical considerations, ESD in Biology education empowers students to become catalysts for positive change in the face of pressing environmental challenges. As we progress, we shall further explore the fundamental tenets and tactics pertaining to the implementation of ESD in biology classrooms, exploring its potential to shape a generation of environmentally aware and socially responsible individuals (Sund & Gericke, 2020).

Competence and Curriculum Development

Integrating competence-based education with deliberate curriculum creation is central to ESD. Together, these components create a fabric that gives learners the tools they need to create a more just and sustainable world. Competence, within the context of ESD, transcends traditional academic prowess and embraces a holistic approach that extends to practical, social, and emotional dimensions. It involves the cultivation of a set of interrelated abilities that empower learners to analyze and solve real-world problems while considering the ecological, social, and economic ramifications of their actions. Competency development is essential in rising a new generation of globally conscious and active citizens at a time when the globe is struggling to find solutions to pressing problems like climate change, biodiversity loss, and socioeconomic injustice. (Erstad, Kjällander & Järvelä, 2021).

Curriculum development in ESD is a dynamic and multifaceted process that goes beyond the mere assimilation of information. It is a deliberate and purposeful endeavor aimed at shaping educational experiences that foster critical thinking, creativity, and a deep sense of responsibility towards the environment and society. The ESD curriculum is not confined to traditional subjects; instead, it is an interconnected web that integrates environmental, social, and economic dimensions, highlighting the interconnectedness of these components in environmentally friendly growth. In recent years, the urgency of addressing global challenges has catalyzed a paradigm shift in educational practices, leading to an increased emphasis on ESD. Policymakers, educators, and stakeholders in the educational landscape recognize the imperative to go beyond rote learning and standardized testing, acknowledging that education must be a transformative

force capable of instilling a sense of agency and responsibility in learners. Consequently, the incorporation of competencies and the development of robust ESD curricula have become pivotal in shaping educational frameworks that prepare students to navigate the complexities of the 21st century (Nsengimana, Rugema Mugabo, Hiroaki & Nkundabakura, 2020).

This introduction sets the stage for a comprehensive exploration of the symbiotic relationship between competence development and curriculum design in the realm of ESD. It delves into the key components that constitute competency-based education, examining how it aligns with the broader goals of sustainable development. Furthermore, it sheds light on the intricate process of curriculum development, unraveling the intricate threads that weave together diverse disciplines to create a cohesive and impactful educational experience. As we embark on this journey, we will uncover the transformative potential of ESD in shaping the minds of future leaders who will be instrumental in steering humanity towards a more sustainable and equitable future (Nsengimana, Rugema Mugabo, Hiroaki & Nkundabakura, 2020).

Related Literature on the Integration of Education for Sustainable Development

Opportunities for pupils to acquire action competence may be provided by school curricula that include the notion of ESD. It was stated by Gooch in 2008. Many nations have started to update their current curriculum to align with the goals of the idea and the choices made, particularly after the release of the UN Decade of ESD statement and Agenda 21 document. In particular, pertinent SD dimensions are linked to existing accomplishments. To better understand the current level of integration and identify opportunities for growth, it is helpful to analyze research that has looked at how Sustainable Development (SD) has been included into educational curriculum. Research has shown that there has to be balance and integration across dimensions, and it has also examined how well various national curricula meet SD goals (Giesenbauer & Müller-Christ, 2020).

To better understand the current level of integration and identify opportunities for growth, it is helpful to analyze researches that have looked at how Sustainable Development (SD) has been included into educational curriculum. Research has shown that there has to be balance and integration across dimensions, and it has also examined how well various national curricula meet SD goals. The UNESCO Hong Kong Association's initiatives to include sustainable development education into K-12 curriculum were investigated by Lee et al. (2016). Results showed that

whereas 62% of lessons dealt with environmental sustainability, just 8% dealt with economic sustainability, indicating a lack of balance in the way these components are integrated into school curriculum. It became clear that there was a need to enhance the curriculum's integration based on successful instances. Using methods like creative problem-solving and behavioral evaluation, Jauhariyah et al. (2020) looked at how physics classes may include ESD into their lessons. The research proved that these methods may be used by students to create a physics curriculum focused on education and sustainable development (Wamsler, 2020).

Barak et al. (2022) compared the sustainable development education programs in Turkey's secondary schools with those in Bavaria, Germany. Based on the research, it seems that the social sciences program in Sweden places a greater emphasis on sustainable development principles, but the geography, nature, and technology program in Germany places a greater emphasis on environmental principles. There was little focus on the economic component in both programs.

The Biology Curriculum of Liberia

The biology curriculum of Liberia is a vital component of the country's educational system, playing a crucial role in shaping the scientific knowledge and understanding of its students. Liberia, located on Africa's west coast, emphasizes education as a method of empowering its inhabitants and contributing to national progress. Within this framework, the biology curriculum is intended to provide students with a solid foundation in the biological sciences, encouraging an appreciation for the variety of life, ecological systems, and the laws that control living beings. The curriculum aims to instill a scientific mindset in students, encouraging them to observe, question, and analyze the natural world around them. By delving into the intricacies of biology, students in Liberia are equipped with the knowledge and skills needed to comprehend fundamental concepts such as genetics, evolution, ecology, physiology, and anatomy. This foundational understanding not only supports academic excellence but also contributes to the development of critical thinking and problem-solving abilities essential for addressing real-world challenges (Hackman, Zhang, & He, 2021).

One of the key goals of the biology curriculum in Liberia is to cultivate an awareness of environmental issues and the impact of human activities on ecosystems. As a country endowed with rich biodiversity, Liberia recognizes the importance of nurturing a generation of

environmentally conscious citizens who can contribute to sustainable practices and biodiversity conservation. This aspect of the curriculum often includes topics related to conservation biology, climate change, and the interconnectedness of living organisms within ecosystems.

Practical and hands-on experiences are integral to the biology curriculum, allowing students to apply theoretical knowledge in laboratory settings and during fieldwork. These practical components not only enhance students' understanding of biological concepts but also foster the development of essential laboratory skills and scientific methodologies. By engaging in experiments and investigations, students gain a deeper appreciation for the scientific process, honing their abilities to collect, analyze, and interpret data (Wehye, 2021).

Furthermore, the biology curriculum in Liberia is designed to be inclusive and adaptable to the evolving landscape of scientific knowledge. The incorporation of contemporary research findings and advancements in biotechnology ensures that students are exposed to cutting-edge developments in the field. This adaptability is vital in preparing students for higher education and careers in science, technology, engineering, and mathematics (STEM) fields, where a solid foundation in biology is often a prerequisite. In conclusion, the biology curriculum of Liberia serves as a cornerstone in the educational journey of its students, fostering a deep understanding of the biological sciences and nurturing the next generation of scientifically literate citizens. By combining theoretical knowledge with practical experiences, the curriculum not only equips students with the skills necessary for academic success but also instills a lifelong curiosity and appreciation for the wonders of the natural world. As Liberia continues to invest in education as a catalyst for national progress, the biology curriculum remains a vital instrument in shaping the intellectual landscape of the country (Hackman, Zhang, & He, 2021).

Gaps in Literature

In the ever-evolving landscape of education, the imperative to instill a sense of environmental consciousness and sustainability has become increasingly apparent. Education for Sustainable Development (ESD) serves as a pivotal tool to equip future generations with the knowledge, skills, and attitudes necessary to address the complex challenges facing our planet. Within the realm of ESD, the biology curriculum emerges as a crucial arena where students can delve into the intricate web of life, fostering an understanding of ecological systems and the delicate balance that sustains biodiversity (Nousheen, Zai, Waseem & Khan, 2020).

While the importance of integrating sustainability principles into education is widely acknowledged, there exists a notable gap in the literature when it comes to examining the specific nuances within the biology curriculum. This lacuna is not merely a scholarly oversight but a significant hindrance to the holistic implementation of ESD. As we navigate the 21st century, marked by unprecedented environmental crises and rapid technological advancements, it becomes imperative to scrutinize the existing literature gaps to facilitate a more nuanced and comprehensive approach to sustainable education within the biological sciences. One of the primary gaps in the literature surrounding education for sustainable development in biology lies in the fragmented integration of sustainability concepts. While general discussions on sustainability in education abound, there is a lack of in-depth exploration of how these concepts can be seamlessly woven into the existing biology curriculum. As a result, educators may struggle to bridge the gap between theoretical sustainability principles and their practical application within the context of biological sciences (Nousheen, Zai, Waseem & Khan, 2020).

Education for sustainable development necessitates a holistic and interdisciplinary approach, transcending traditional subject boundaries. Unfortunately, the existing literature often fails to delve into the potential cross-disciplinary connections that could enhance the efficacy of sustainability education in biology. Integrating elements of geography, chemistry, and environmental science, for instance, could provide students with a more comprehensive understanding of the intricate relationships within ecosystems. Another critical gap lies in the insufficient exploration of effective pedagogical strategies tailored to the biology curriculum. While the importance of incorporating hands-on experiences, case studies, and real-world applications is acknowledged, the literature often lacks a detailed examination of how educators can practically implement these strategies. The absence of concrete guidance hampers the ability of educators to translate theoretical frameworks into engaging, meaningful learning experiences for students (Alam, 2022).

Education for sustainable development is inherently linked to socio-cultural contexts, and biology, as a discipline, is not exempt from this interconnectedness. Yet, literature gaps persist in adequately addressing how cultural perspectives, societal norms, and local contexts influence the effectiveness of sustainable education within the biology curriculum. Understanding these dynamics is crucial for tailoring educational approaches that resonate with diverse student populations. With the accelerating pace of scientific discovery, new biological issues continually

emerge, demanding attention and analysis. Unfortunately, the literature on education for sustainable development in biology often lags in keeping pace with these developments. Consequently, students may graduate without a deeper understanding of the latest challenges and potential solutions in the realm of sustainable biology (Kopnina, 2020).

In conclusion, the gaps in the existing literature on education for sustainable development within the biology curriculum underscore the need for a more nuanced and comprehensive exploration of this critical intersection. Addressing these gaps will not only enhance our understanding of how to effectively integrate sustainability principles into biology education but also contribute to shaping a generation of environmentally conscious individuals equipped to tackle the complex challenges of the future. In subsequent sections, this investigation will go into specific methodologies, case studies, and suggestions to fill these gaps, paving the path for a more comprehensive and sustainable approach to biology teaching. (Kopnina, 2020).

CHAPTER II
Methodology

This chapter focuses on the procedures and method that were used to carry out this study. A comprehensive description of the methods used is given in this section of the research. The data sources and analytic procedure for the content analysis are explained in the first section. In the concluding part, we explore the research's shortcomings.

Research Design

Researchers may get important insight into human behavior via the investigation of different kinds of communication through content analysis. Analyzing the usual, but not limited, textual components of communication is what content analysis is all about (Lindgren, Lundman & Graneheim, 2020). Reliable and accurate conclusions may be drawn about the link between papers, signs, sights, and sounds within their particular settings by using content analysis as a research approach (Kyngäs, 2020).

The qualitative technique, which was evaluative, was the primary focus of this study, which drew its data from secondary sources. The researcher conducted content analyses on the biology curriculum of Liberia in terms of its intricate link to the sustainable development goals focusing on education for sustainable development (ESD).

From 2010 to 2012, students in Liberia's tenth through twelfth grades followed the National Biology Curriculum. To determine if these sources incorporate the three pillars of sustainable development (SD)—economic, social, and environmental—we use a content analysis approach. Presenting these qualities as a cohesive conceptual framework in Table 1, they are used as categories for coding in the content analysis process.

Participants

The researcher will use the purposive sampling technique to collect the data. A purposeful sample is a non-probability sample selected in accordance with the characteristics of the population and the objectives of the study. The researcher chose to use this sampling technique because the study involved the biology curriculum of Liberia and its alignment with the SDGs objectives and dimensions.

Analysis of National Biology Curriculum of Liberia

The content analysis in this research is derived from the National Biology Curriculum. In 2011, the Liberian Ministry of Education sanctioned a new curriculum. It has been in use continuously since its 2012 introduction, beginning with tenth grade. The first section of the curriculum lays out the overall goals and purpose of the program; the second section discusses how the program will be put into action; and the third section includes the goals and descriptions of each grade level's program for grades 10, 11, and 12.

All of the curricular modules' goals are classified in the content analysis according to the sustainable development aspects. The first draught of the curriculum data is created by marking objectives connected to these aspects and education for sustainable development. The research advisor and two separate specialists met to determine the associated goals. In order to answer research question 1, the education for sustainable development goals were finalized after consulting with experts and the adviser.

Data Collection

The data for this research was sourced from several sources, including the biology curriculum of Liberia, the government of Liberia national education development plan and reports from the United Nations on the progress of the SDGs, books, thesis, and websites.

Data source	Explanations
1The United Nations Sustainable Development Goals (SDGs)	Seventeen goals with 169 targets declared by the UN (UN, 2015)
2.2011 Liberia High School Biology Curriculum	A total of 181 objectives Analysis based on objectives of the curriculum Updated in 2011 Comprised 10^{th} to 12^{th} grade There are six periods according to grade level There are five units include Outcome, content, activities, materials/resources, and evaluation
3.2023 Master's Thesis	Topic CONTENT ANALYSIS OF NATIONAL HIGH SCHOOL PHYSICS CURRICULUM OF TURKEY AND PHYSICS COURSE TEXTBOOKS IN TERMS OF EDUCATION FOR SUSTAINABLE DEVELOPMENT By EKİN SU KAPLAN
4.2019, September master's Thesis	Topic ANALYSIS OF SCIENCE CURRICULUM AND TEXTBOOKS IN TERMS OF SUSTAINABLE DEVELOPMENT GOALS: A CASE STUDY By EDA TATLILIOĞLU
Articles	y, C., & Rigon, A. (2019). Bringing Agenda 2030 to Life. Liberia Sustainable Development Report. M., Zhang, Q., Sroufe, R., & Ferasso, M. (2020). The social dimensions of corporate sustainability: an integrative framework including COVID-19 insights. Sustainability, 12(20), 8747.

Data Collection Procedures

Data was gathered from prior sources, including papers, books, media reports, government organizations, press releases, and thesis And the approach for this study was based on the data acquired from those sources. Secondary research, in contrast to primary research, is characterized by its speed, ease of use, and cost-effectiveness. The objective is to get a more comprehensive grasp of the subject topic. In accordance with the subject matter, the use of search engines such as SSCIE, SCI, SCOPUS INDEX, Google scholar, JSTOR Master Thesis led to the discovery of articles that were of great assistance.

Data Analysis

The information was subjected to a qualitative evaluation. The researcher conducted inquiry utilizing the available data from the biology curriculum of Liberia, other relevant textbooks on Liberia and a number of sources. With the collected data, the researcher then used those pieces of information to analyze how the biology curriculum of Liberia integrates the sustainable development goals.

CHAPTER IV
Findings

The researcher used the Liberian Ministry of Education-approved National High school Biology Curriculum to compile the data used in this section of the study. In this data presentation we use content analysis to categorize the collected data based on the three pillars of sustainable development and the integration of sustainable education. Levels 10, 11, and 12 have their own set of curricular goals that pertain to the aspects of sustainable development. Separate tables provide all numerical numbers and names of level-marked goals. In addition, the aims of sustainable development education are examined in relation to the relevant biological content for each target pertaining to the sustainable development aspects.

Individuals with the skills to create new information, find solutions to problems, think critically, and make positive contributions to their communities and cultures are the intended beneficiaries of the National Biology Curriculum. The primary objectives of the National Biology Curriculum of Liberia include teaching students how biology is fundamental for understanding the natural world, how to create and disseminate scientific knowledge, the impact of biology on society, the economy, and technology, and how to draw conclusions about socio-biological events connected to the utilization of various energy sources.

The National Biology Curriculum of Liberia has 181 objectives spanning from 10th to 12th grade that may be used to achieve these aims. The curriculum's 23 goals are all connected to sustainable development in some way. One of these goals exemplifies each of the three pillars of sustainable development. Related objectives are shown according to the grade level in Table 1.

Table 1

Number of ESD related objectives of each grade

Grades in Curriculum	**Number of Objectives**	**Number of ESD Related Objectives**
10th Grade	The branches of biology 2. branches of biology The traits of a live thing, such as reproduction 4. Describe the cell's shape and make-up, and talk about what they do. 5. Explain how cells, organs, and processes work on a simple level. 6. Draw and name the light microscope's parts 7. Show how to use the microscope to look at an object 8. Tell the difference between eukaryotic, prokaryotic, and atypical cells. 9. List the ways that plant and animal cells are different. 10. The movement of things inside and outside the cell	10.1• Biology branches defined: Botany, Zoology, Anatomy, Histology, Physiology, Ecology, Entomology, Cytology, Virology, Bacteriology, Microbiology, Mycology, Parasitology, Endocrinology, and Ichthyology. 10.2 - Biological instruments Microscope 10.2.1• Authors: Identify the nationality and significant contributions of the following individuals: a) Aristotle b) Carolus Linnaeus c) Linnaeus 10.2.3 • Living and Non-living entities: a) Criteria for distinguishing living organisms from non-living entities: feeding, respiration, excretion, irritability, b) Traits and instances of plants and animals. c)

	11. The variety of live things and how to group them 12. Talk about how taxonomy works . 13. Talk about how viruses affect living and nonliving things . 14. List the most important things about each country; bacteria are called prokaryotae, whereas protists are called protista. Fungi are called fungi, plants are called plantae, and animals are called animalia. . 15. Draw and name an organism that is typical of each group. 17. Put living things into groups such as kingdom, phylum, class, order, family, genus, and species . 18. Describe the main traits of creatures with only one cell. 1 9. Sketch and name the ameba, paramecium, trypanosome, and plasmodium 20. Describe the traits that make unicellular creatures live things. 21. Name the single-celled organisms that cause diseases and the diseases they cause. 22. Explain what epithelium, connective muscle, nerve, and adipocyte organs do. 23. discuss the idea of an organ as a collection of tissues. 24. Describe what complex creatures are like. 25. Describe what sponges are like in general terms. 26. Describe the shape of hydra and its basic life traits. 27. Put worms into groups and describe the main changes in their structures. 28. Explain how flatworms and roundworms feed on other organisms, including their life cycle and other places they can live. 29. Steps the government is taking to stop parasitic worm diseases 30. Based on their shapes, tell the difference between the leech and the earth worm. Explain the earth worm's shape, how it eats, breathes, excretes, and reproduces, as well as its economic value. 32. Talk about the general traits of arthropods 33. Describe the grasshoppers, weevils, and cotton strainers' outward and internal traits, as well as how they live, how they've adapted to their environments, and how important they are to the economy. 34. Describe the two types of change that arthropods go through	Differentiating traits and examples - Euglena, a creature that straddles the boundary between animals and plants 10.3• Cell: a) The basic structure and duties of the parts that make up a cell. b) Ways cells move things around: osmosis, diffusion, assisted diffusion, active transport, and endocytosis (pinocytosis and phagocytosis). Sorting living things into groups and what that means 10.4: The order of taxonomy: Kingdom, Phylum, Class, Order, Family, Genus, and Species 10.4.1. Single-celled organisms a) Pathogens that cause sexually transmitted infections: Fungi, Bacteria, Viruses, Protozoa Sarcodina is an amoeba that causes dysentery. - impact and prevention b) Ciliate paramecium c) Flagellate euglena, trypanosomes d) Protozoa (plasmodium) Malaria Because

	; 35. Talk about the role that cockroaches, mosquitoes, and houseflies play as carriers. 36. What are some general things you know about butterflies? 36. Talk about how honey bees help the economy and 37. Talk about bugs, how they affect businesses, and how to get rid of them. 38. Explain what plants, algae, mosses, and mushrooms are, how they grow, and how they live. 39. Explain why algae and fungus are important to human economics 40. Explain how algae reproduce (sexually and asexually). 41. Describe the different ways that mushrooms get food, using words like parasitic and saprophytic: 42. Name some common fungus diseases that affect people and plants, like athlete's foot, ringworm, and blight. 43. Describe the process of photosynthesis. 44. List the traits of flowering plants and tell them apart from each other. 45. Describe what makes a growing plant do well. 46. Classify flowering plants into monocotyledonae (monocots) and dicotyledonae (dicots). 47. Explain what makes monocots and dicots different 48. Explain how roots, stems, leaves, and flowers of flowering plants are built and what they do. 49. Talk about how blooming plants reproduce sexually and asexually. 50. Draw a flower and name each part, explaining what it does. 51. Find the flower formulas for Rosa showy (Delonix), Rosa Pride of Barbados (Caesalpinia), and Rosa Rattle Box (Crotalaria) and write them down. 52. Name the different kinds of pollinators and the things that do the pollinating. 53. Explain how zygotes and embryos are made in blooming plants. 54. Describe the factors that allow seeds to grow 55. Name the different kinds of foods and explain how they spread.	
11th Grade	3. Categorize viruses according to their nucleic acid composition (DNA or RNA) and the specific creatures they infect. 4. Explain the virus's life cycle. 5. Provide examples of viral infections, their transmission routes, and preventative techniques. 6. Examine different types of microorganisms and study them via microscopes. 7. Categorize microorganisms and create a diagram illustrating a typical bacterial cell with labels. 8. Enumerate and explain typical bacterial infections together with their symptoms.	11 1.2 Grouping: a) bacteriophages b) viruses in animals c) viruses in plants A bacteriophage has the following structure: 11.3. a. Ecology b) The common cold, influenza, mumps, chicken pox, rabies, polio, and HIV/AIDS are all examples of viral infections. The following are four examples of STIs: a)

	9. List preventative actions for bacterial illnesses. 10. Recognize the differences between facultative, anaerobic, and autotrophic feeding. 9. List preventative actions for bacterial illnesses. Differentiate between autotrophic and heterotrophic feeding; and aerobic, anaerobic, and facultative respiration. 11. Elucidate the economic significance of bacteria. 12. Define the notion of nutrition. 13. Justify the need of energy for living organisms. 14. Summarize and categorize the various nutrients included in food.. Provide the structural formulas for carbohydrates, proteins, and lipids. 15. Explain the significance of nutrients included in diet. 16. Display the existence of different nutrients included in food. 17. Identify the dental formula of an animal. 18. Elucidate the significance of dental care in humans. 19. Define a balanced diet. 20. Define malnutrition . 21. List and explain several food preservation and storage methods. 22. Preserve food using resources available locally. 23 . Give an account of the biological justifications for food preservation and storage. 24. Differentiate between loamy, sandy, and clay soil types. 25. Explain how soil fertility is affected by erosion. 26. List the elements that make up soil. Twenty-seven. Explain the repercussions from over using soil. 28. Describe the processes for preserving soil, maintaining it, and restoring its fertility. 29. Talk about the benefits and drawbacks of using the slash-and-burn method in farming. Learn about the ways different animals isolate their eggs and offspring. 31. State the difference between an organism's habitat and its ecological niche. 32. Give an explanation of population and how variety in populations is 33.defined. Explain ecological succession (question 34. Outline the many ways in which different kinds of creatures interact with one another Analyze the ecosystem's trophic systems via the use of numbers pyramids, food webs and chain diagrams. Learn the difference between primary productivity (gross) and net primary productivity (net) and how ecosystem productivity is defined. 37. Analyze the transfer of energy within the trophic system and the cycles of water, carbon dioxide, nitrogen, phosphorus, and sulfur. 38. Describe methods for preserving natural resources. connection to their environment and 39. Explain how species are defined in how they go about reproducing independently. 40. Recognize that an organism's ecological niche is distinct from its environment. 41. Explain what populace density is and how it is defined. Find the birth rate, mortality rate, percentage growth rate, doubling time, and population growth rate (42). The variables that affect the size of a population may be either density-dependent or density-independent; distinguish between the two. Keep in mind that emigration and immigration are not the same thing. Discover the logistic model, sigmoid growth curve, and exponential	ways to decrease the risk of transmission and a). Definition and categorization of nutrition: b) Autotrophic nutrition c) Heterotrophic nutrition d) Holozoic nutrition e) Saprobiontic nutrition e) Parasitic nutrition f) Mutualistic nutrition 11.5 a). Food, nutrients (carbohydrates, lipids, proteins, vitamins, etc.), and energy. Methods of food preservation: a) ionizing radiation b) drying c) salting d) smoking e) parboiling f) dehydration g) refrigeration Significance of food preservation 11.6 Soil: a. soil formation b. soil composition c. soil kinds d. soil fertility e. soil erosion: causes and prevention f. soil conservation g. soil maintenance h. soil fertility renewal d) Weathering: (a) Physical weathering, (b) Chemical weathering. 11.6.1 Production of food and cash crops in Liberia 11.6.2 Impact of non-biodegradable chemicals on soil fertility 11.6.3 Species Isolation Mechanisms 5. Interspecific interactions (Biological connections) Options: (a) mutualism, (b) commensalism, (c) predation, (d) parasitism, (e) competition 11.6.4 Trophic levels consist of autotrophs (producers), heterotrophs (consumers), and food chains and webs. 11.6.7 Conservation of nature includes soil, forest, wildlife, oil, and mineral conservation. 11.6.7 Biocycles in nature include the water, carbon, nitrogen, phosphorus, and sulfur cycles. 11.6.8 Organisms' environment and ecological niche 11.6.9 The following factors contribute to a population's density: a) growth rate; b) doubling time; c) percent growth rate; e) birth and death rates. f) factors that are reliant on density and those that are not, as well as immigration and emigration

	curve (number 45). Reproduction may be either asexual or sexual. Types of asexual reproduction are described and listed in 47. 48. Elaborate on the stages of the cell cycle. 48. Please explain the cell cycle in more detail. 49. Describe the steps of mitosis and provide illustrations of each. 50. Do not confuse mitosis with meiosis; instead, explain what meiosis is and why it is important for sexual reproduction. Chapter 51: Nucleic Acids aims to define and identify the many forms of nucleic acids. Give an explanation of the DNA double helix model (question 52). The process of DNA replication may be summarized as follows: 53.Give an explanation of how RNA transcription works. 54. Protein synthesis is described in detail in section 55. 56. Give further details on how proteins are made and give some instances of man-made proteins. 57. Define heredity, genetics, and sexuality. Explain the process of how traits are inherited. 58. Define nucleic acids and list the several kinds of nucleic acids.	11.7 Ecological succession involves primary and secondary successions, as well as pioneer and climax communities. 11.7.1 There are two kinds of nucleic acids: a) DNA b) RNA c). Nucleotide structures d) 11.7.2 Complementary base pairing. Comparison of DNA and RNA structures. DNA duplication. Transcription of RNA 11.7. Three phases of protein synthesis. RNA Variants. Significance of protein synthesis 11.7.4 Inheritance and genetic principles: a) Genetics principles b) Mendel's garden pea experiment; c) Genetic terms: phenotype, genotype, alleles, hybrid, homozygous, heterozygous, monohybrid, dihybrid, dominant, and recessive genes Section 11.7.6: Heredity Characteristics: hemophilia, mental illness, sickle cell anemia, color blindness, baldness, prominent ear lobes, and more. a) Influence of environment on genetics b) Evolution of characteristics: Intelligence c) The ABO blood group.
12th Grade	1lk about what happens to pyruvate. . 2. Talk about how birds have changed to be able to fly. 3. Describe the outside and inside parts of birds. 4. List and name the different types of animals 5. Name some parts inside animals and explain what they do. 6. Put mammals into groups based on how they reproduce and how their feet are built. 7. Describe how swimming, flying, and primitive animals keep their bodies at the right temperature . 8. Name the parts of the human skeleton. 9. Explain what the spinal system does for the body. 10. Name the different types of joints and describe where they are located. 11. Name the three types of muscle cells and explain what they do. 12. Talk about how sexually transmitted diseases (STIs) and drug abuse affect the skin, muscles, and bones. 13. Describe the changes that happen to the body during youth. 14. Describe the process of making a gamete. 15. Explain what the male and female sexual parts do. 16. Draw the sexual systems of both men and women. 17. Describe what a sperm cell looks like and what it does. 18. Talk about the menstrual cycle 19. Could you describe the effects of gender-based violence on reproductive health?	12.1 Birds: a) general characteristics b) outward and internal characteristics c) types of birds (flying and non-flying) d) flying's evolutionary history e) feather types 12.1.1 Animals: Feminine and masculine characteristics Dentition with dental formulae, reproductive systems, orders of mammals, characteristics of each order, and the typical shape of a mammalian molar tooth are all covered. Methods for controlling core body temperature in avian, aquatic, and caveman species in section 12.1.3The human body is divided into the head, neck, trunk, and appendages. It also includes bodily cavities. 12.2.1The skeletal system is composed of bones, cartilage, ligaments, and tendons. It is divided into regions. - spinal column skeleton of the appendages c) Bone and skeletal system functions d) Joint types and

	20. Name the parts of the digestive system. 21. Talk about nutrients, food groups, and what each one is used for. 23. Explain what an enzyme does in the eating process. 24. Explain what minerals and vitamins are and why they're important for the body. 25. List the parts of blood and explain what they do and how blood clots. 26. Look at blood through a lens to see the red and white blood cells. 27. Describe what the heart does. 28. Describe what arteries, veins, and capillaries do. 29. Name and describe the different types of circulation 30. Talk about the lymphatic system, what it does, and what kinds of things make up lymph. 31. Describe how lymph nodes are built and what they do. 32. Name the other lymphoid organs (tonsils, spleen, thymus) and explain what they do. 33. Describe the process of elimination. 34. Name and describe the kidneys, ureter, and urine bladder's jobs. 35. Explain how other systems, like the skin, liver, lungs, and big stomach, get rid of waste. 36. Explain how the excretory system helps keep the body's balance. 37. Describe the two types of breathing. 38. List the cells and organs that help breathing work. 39. Talk about how drug abuse and STIs affect the two systems (the intestines and the lungs). 40. Talk about cellular respiration and list the main steps that make up a metabolic system with many reactions (Glycolysis, link reaction, Krebs cycle, and electron transport chain). 41. Explain the difference between aerobic and anaerobic breathing 42. Talk about anaerobic respiration in muscles and alcoholic respiration in yeasts and plants. 43. Talk about what phosphorylation means in glycolysis 44. Name the end products of glycolysis. 45Talk about what happens to pyruvate. 46. Talk about oxidation and reduction in terms of oxygen, hydrogen, and electrons. 47. Tell the difference between dehydrogenation processes and decarboxylation reactions 48. Name the four main things that happen during glycolysis. 49. Write down the overall equation for respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6OCO_2 + 6H_2O$. 50. The inner membrane of the mitochondria contains three kinds of electron carriers: cytochromes, flavoproteins, and quinones. 51. Compare and contrast how the nerve and endocrine systems work 52. Explain how the brain and a cell are put together and what they do 53.List the different types of neurons 54. Mark the main parts of the nerve system on a drawing of it. 55. Describe the spinal cord's shape and how it works. 56. Name the different parts of the spinal cord 5 7. Name the central and peripheral nerve systems and explain what they do. Choose between actions that are voluntary and actions that are not optional. 59. Talk about what causes drug usage and how it affects the nerve system. 60. Describe the eye and ear's parts and how they work. 1. Describe the effects of some STIs on the nervous system.	their functions 12.2.3 The musculoskeletal system: Different kinds of muscles and what they do a. The effects of STIs and substance abuse on the musculoskeletal and reproductive systems. b. Growth throughout adolescence. Gamete formation: a) oogenesis and b) spermatogenesis 12.2.4 Reproductive systems of sexes 12.2.8. Cells Used for Reproduction Chapter 9: The Hormones a. Conception and fertilization b. Sexual determination c. Infertility d. Sexual cycles e. STDs: - ways in which they are transferred and ways to avoid them 12.3 The HIV/AIDS pandemic: a look at the immune system, risky behaviors, care and support, prejudice and stigma, and the need of testing. Gender-based violence and family planning 12.3.2 Digestive system: a) nutrition - categories of food and their distinct functions The alimentary canal consists of the mouth (including teeth and tongue), esophagus, stomach, intestines, exocrine glands (such as salivary and pancreatic glands), and the liver along with its activities. 12.5. The heart and blood vessels 1. The heart and its arteries. 2. The circulatory system. 3. The cells and plasma that make up the blood. 4. The two main types of circulations, the systemic and the pulmonary. 12.6, Blood types and Rh factor. Drug abuse's affects on the heart and blood vessels A portion. System of lymphatic's: liquid (b), lymphatic vessels (c), lymph nodes (d), and lymphocytes (e), which include both B-cells and T-cells, 12.7 Explanation of natural resources 12. 7.1 Renewable and non-renewable natural resources 12.7.2. Explanation and instances of renewable resources flow 12.8.1 Preserving

	662. List the roles of exocrine glands, endocrine glands, and hormones. 63. discuss how negative feedback controls the release of hormones .6 4. Describe the idea of natural resources. Identify natural materials that can be used again and again and those that can't. 66. Talk about how important nature resources are 67. Show how wild resources can be protected. 68. Explain the ecosystem method to managing natural resources.	natural resources a) Explanation of pollution b) Factors leading to pollution: c) air pollution d) fresh water e) soil f) sea g) thermal f) noise 12.9.1. Pollution Control 8. Vaccination and immunization 12.9.2 Personal hygiene 12.9.3. Substance misuse 12.10 Public sanitation =12.10.2 The term "sewage disposal" encompasses both the process of removing sewage and the process of defining sewage. a) Privatizing sewage treatment for business use. b) Water: c) Where it comes from, d) How it becomes polluted, e) How to clean it up, and f) What to do with the trash afterward. 12.11.1, first Resting potential, action potential, refractory period, and conduction of nerve impulses are all discussed in this section, along with their production and transmission. How synapses and myelin sheaths work and what they convey Research into the structure and function of synapses 12.11.2 Actions categorized as voluntary or involuntary 6. Reflexes and reflex arc 12.11.3. The functions and significance of the autonomic nervous system 8. Anatomy and physiology of the eye and ear 12.11.4. Impact of Sexually Transmitted Infections on the Nervous System Organs Substance abuse: etiology, impacts, and mitigation
Total	**181**	**23**

Table 1 shows that the Liberian National Biology Curriculum has 181 course objectives. Although the highest number of goals is attained in 12th grade, the lowest degree of accomplishment is attained in 10th grade. There was a maximum of eleven goals pertaining to sustainable development education in the twelfth grade, with the lowest number of goals being identified in the tenth grade.

Table 2

Number of objectives related with dimensions of SD

Grades in Curriculum	Number of objectives related with dimension of SD for ENV	Number of objectives related with dimension of SD for ECO	Number of objectives related with dimension of SD for SOC
10th	Definition of biology and its branches. Plants and animals importance, characteristics of cells. Preservation of living organism 2	1. Economic importance (food, medicine and industry The significance of arthropods to the economy a). B. Honey bees. Economic significance of pests Biological control Chemical control	Viruses and their infect on human life STI and STD infection Reproduction sexual and asexual The importance of water sanitation **3**
11th	1. Soil and its formations 2. Climax change. Causes and infect on the environment 3. Inter-specific interactions	1.Liberia food and cash crop production Immigration factors and causes **3**	1. Virus: a) General characteristics a) definition b) size & shape c) Composition Structure 2. Viruses of the following classifications: a) bacterial, b) animal,

	(Biological association Conservation of nature (a) soil conservation 4. Bio cycles in nature (a) (b) the sulfur cycle; (c) the carbon cycle; (d) the phosphorus cycle; and (e) the nitrogen cycle. the organism's environment and ecological niche. Part A: Density of population; Part B: Rate of population increase; Part C: Time needed for population to double D) Rate of increase as percentage annals of births and deaths f) moving to and from a country, traits that are density-dependent and density-independent 5. Evolution of ecosystems: (a)		and c) plant 3. Nutrition and definition a) food nutrients b) malnutrition c) balance diet d) method of food preservation 4. Cycles of life a) Frequent viral illnesses include influenza, mumps, chickenpox, rabies, polio, and HIV/AIDS. 5. STIs: a) How to avoid getting them and what causes them

	precursory and climax successions; (b) primary and secondary successions		
12th	1. Refuse collection and disposal 7. 2. Water: a) Where it comes from b) How it gets dirty or polluted c) How it can be cleaned 3. What does pollution mean? A. Pollution has eight sources: b) air pollution; c) fresh water; d) land; e) sea; f) heat; g) noise; and h). Getting rid of pollution 4. sewage disposal: a) what waste	1 .Definition of natural resources 2.2 Natural materials that can be used over and over b) What flow green resources are and some examples of them 3. Keeping wild resources safe 1. Getting vaccinated and immunized 2. Taking care of your own cleanliness 4. Abuse of drugs Cleanliness in the crowd 5. Uses of sewage for business 6. Water: a) Where it comes from b) How it gets dirty or polluted c) How it can be cleaned 7. Collection and	1. Elucidate the skeletal and muscular impacts of substance abuse and sexually transmitted infections (STIs); b) Analyze the pathogenic mechanisms underlying HIV&AIDS; 2. Describe the physiological maturation that occurs during adolescence. 3. Describe the step by which gametes are formed. 4. Elucidate on the respective functions of the reproductive organs of the sexes 5. Create male and female reproductive organ illustrations a). Elucidate on the

	disposal is and how it works 7. Explain what minerals and vitamins are and why vitamins are important for the body.	dumping of refuse 8. Some general things about birds and animals	composition and operation of a sperm cell. b). Particulate the reproductive cycle. 6. Elucidate the medical ramifications of gender-based violence on reproductive health 7. Describe the advantages of family planning and the diverse methods employed
Total	**14**	**13**	**15**

The 14 goals that make up the environmental component of SD in the Liberia National High School Biology Curriculum are listed in Table 2. From the tenth grade, two goals are included, five from the eleventh, and seven from the twelfth grades. As for the SD curriculum's economic component, there are thirteen goals to work for. This includes two goals from the tenth grade, three from the eleventh, and eight from the twelfth. Finally, fifteen goals are associated with SD's social component.

Table 3

ESD modules and goals together with their corresponding codes as outlined in the curriculum

Grades	Units	Number of Objectives	Number of ESD related Objectives	Codes of ESD related Objectives in Curriculum

10th	**1.Definition of Biology** **2. Branches of Biology** **3Differentiating characteristics between living and nonliving entities** **4. Unicellular organisms** **5. Human reproductive structure**	List some individuals who have contributed to the advancement of biology. Discuss the structure, composition, and functions of the cell. Define taxonomy and describe the wide variety of life on Earth. 2. Talk about where taxonomy comes from 4. Talk about how viruses affect both living and nonliving objects 5. Go over the criteria used to identify and categorize organisms	- - - - -	10.1.2.4. 10.1.4.1. 10.1.4.2.

11th	**1.Virus Definition** **2. Food and Nutrition** **3. Effect of non-biodegradable substances on soil fertility** **4. Liberia food and cash crops production** **5. Conservation of nature**	Give a rundown of the traits shared by viruses. 2. Outline the four techniques used in the research of viruses 3. Organize viruses according to the types of the creatures they target. 3. Describe the stages of a virus's life cycle. 5. Give an example of	- One, the virus: a) Basic features 1) description; 2) dimensions and form; 3) chemical make-up 2. Viruses belonging to the following categories: (a) Microbes, (b) Mammals, and (c) Vegetation Thirdly, food and its description a)	11.1.1.3.

		a viral illness, how it spreads, and what you can do to stop it. 6. Identify and describe different types of microorganisms by using microscopes to examine them 7. Identify bacterial classes and illustrate and identify a common bacterial cell **4.** Give an explanation of what nutrition is. Discuss the need of energy for all forms of	Nutrients in food; b) Low nutrition; c) Dietary balance; and d) Food preservation technique 4. The life cycle a) Common viral diseases include the common cold, mumps,	

		life. 3. Describe and organize the several nutritional categories contained in food. 4. Identify the building blocks of carbs, proteins, and lipids by writing their formulas.		
12th	**1. Birds** **2. Definition of natural and**	Give an overview of what makes animals different from birds and	**-** **Give an overview of what makes**	12.1.2.3.

	renewable resources **3. Definition of pollution** **4. Conservation of natural resources** **5. Division of human body**	mammals. 2. Describe the changes that birds have undergone to become aviators. 3. Outline the ins and outs of avian anatomy Defining and describing natural resources 2. Define natural resources that can be renewed and those that cannot. 3. Evaluate the value of non-renewable resources 4. Detail strategies for preserving the earth's natural bounty. 5. Describe the ecosystem approach to managing natural resources. 6. What does the word "pollution" mean?	**animals different from birds and mammals.** **2. Describe the changes that birds have undergone to become aviators.** **3. Outline the ins and outs of avian anatomy** Separate natural resources that can be used again and again from those that can't. 3. Talk about how important nature materials are 4. Talk about ways to protect natural resources.	12.3.4.4. 12.4.2.2.

		7. Trace the origins and consequences of pollution 8. Explore strategies for managing pollution 9. Vaccination and inoculation are crucial tools in the fight against human disease.	-	

In the tenth grade, not a single one of the five units (refer to Table 3) has any ESD-related goals. Additionally, eleventh grade has five units, although four of them have ESD-related goals. The 12th grade curriculum consists of 5 units; however, ESD-related goals are included in 3 of them.

Chapter one of this research, the researcher laid out five major questions that must be addressed in this study findings based on the available date provided in the tables on Liberia's biology curriculum. First, the researcher asked the question below:

Question 1: How well does the quality of the current biology curriculum in Liberia align with the principles and objectives of the SDGs?

The biology curriculum in Liberia now shows a significant agreement with the ideas and goals of the Sustainable Development Goals. (SDGs), reflecting a commitment to fostering holistic education that addresses global challenges. The curriculum integrates key biological concepts with a focus on environmental sustainability, health, and biodiversity, mirroring the interconnected nature of the SDGs.

In the realm of environmental sustainability, the curriculum places a significant emphasis on ecological principles and conservation practices. Students are exposed to topics such as ecosystems, climate change, and biodiversity conservation, Aligning with SDGs 15 (Life on Land) and 14 (Life below Water). By fostering an awareness of the precarious equilibrium that exists between human actions and the natural world, the curriculum equips learners with the knowledge to contribute to the conservation of terrestrial and aquatic ecosystems.

Furthermore, the biology curriculum in Liberia incorporates health-related content, in accordance with SDG 3 (Health and Well-being).Topics such as human anatomy, physiology, and disease prevention are integrated into the coursework, fostering an awareness of health issues and promoting a proactive approach to well-being. This emphasis on health education positions students to become informed advocates for community health, thereby contributing to the achievement of SDG 3's objectives.

In addressing the broader goals of sustainable development, the curriculum also delves into the interconnectedness between biological systems and human societies. Through an examination of the consequences of human actions on ecosystems and the ensuing ramifications for sustainable development, students establish connections to Sustainable Development Goals 1, 2, and 12. This interdisciplinary approach encourages learners to consider the broader socio-economic context in which biological principles operate, fostering a sense of responsibility towards achieving a more sustainable and equitable world.

Despite these commendable alignments, continuous efforts are essential to ensure that the biology curriculum in Liberia remains dynamic and responsive to evolving global challenges. Regular updates and integration of emerging scientific knowledge can further enhance the

curriculum's effectiveness in addressing the multifaceted aspects of sustainable development outlined in the SDGs. In conclusion, the current biology curriculum in Liberia serves as a foundation for nurturing environmentally conscious and socially responsible individuals, contributing to the realization of the Sustainable Development Goals on both a national and global scale.

Question 2. What specific topics within the biology curriculum contribute directly to the promotion of sustainable development as outlined in the SDGs?

The field of biology plays a pivotal role in addressing contemporary global challenges, with an increasing focus on sustainable development as articulated in the United Nations' Sustainable Development Goals (SDGs). The objective of sustainable development is to ensure that the ability of future generations to fulfill their own requirements is not compromised while addressing the demands of the present. Within the expansive realm of biology, several themes and topics contribute directly to the promotion of sustainable development by addressing environmental, social, and economic dimensions outlined in the SDGs. This multifaceted contribution underscores the crucial role of biology education in fostering a deeper understanding of ecological systems, biodiversity conservation, and the intricate interplay between living organisms and their environments.

One of the central themes within the biology curriculum that aligns with sustainable development is biodiversity conservation. The preservation of diverse life forms is critical for ecosystem stability and resilience. Students studying biology delve into the intricate relationships between species, the importance of genetic diversity, and the role of ecosystems in providing essential services, such as pollination, water purification, and climate regulation. Comprehending these principles enables individuals to recognize the importance of biodiversity in preserving ecological equilibrium, thus making a positive contribution to Sustainable Development Goals (SDGs) including Life on Land (SDG 15) and Life below Water (SDG 14).

Additionally, biology education addresses the impact of human activities on the environment, fostering an awareness of the ecological footprint associated with various practices. Topics such as deforestation, pollution, and overexploitation of natural resources are explored, enabling students to recognize the consequences of unsustainable practices. Advocating for legislation that encourage sustainable resource management and making informed decisions are both made

possible by this information. Management, Climate action (SDG 13) and responsible consumption and production (SDG 12) are examples of SDGs that should be aligned with.

Furthermore, the study of biotechnology and genetics within the biology curriculum contributes directly to several SDGs, in particular, the eradication of poverty (SDG 1) and hunger (SDG 2). Students study genetically modified organisms, precision agriculture, and sustainable farming techniques to improve agricultural yields and food security while reducing environmental harm. Biotechnological advancements, such drought-resistant crops and disease-resistant types, show potential in tackling global issues of food supply and delivery.

Another vital aspect of biology education in the context of sustainable development is the exploration of ecosystems and their services. Students gain insights into the importance of wetlands, forests, and other ecosystems in supporting human well-being. By understanding the concept of ecosystem services, individuals are better equipped to advocate for the conservation and restoration of these habitats, aligning with SDGs like Clean Water and Sanitation (SDG 6) and Good Health and Well-being (SDG 3).

In conclusion, the biology curriculum encompasses a rich tapestry of themes and topics that directly contribute to the promotion of sustainable development as outlined in the SDGs. From biodiversity conservation to the exploration of the environmental impact of human activities, biology education empowers individuals to comprehend the interconnectedness of life on Earth. By fostering a deep understanding of these concepts, biology educators play a crucial role in shaping environmentally conscious and socially responsible citizens who can actively contribute to a sustainable and equitable future.

3. To what extent does the biology curriculum of Liberia incorporate cross-disciplinary approaches to address the environmental, social, and economic dimensions highlighted in the SDGs?

In the dynamic landscape of contemporary education, the role of curriculum development becomes increasingly crucial, especially when addressing complex global challenges. Liberia, a nation with a rich cultural heritage and a commitment to sustainable development, stands at the crossroads of shaping its educational framework must adapt to a world that is changing at a dizzying pace. The biology curriculum plays a crucial role in science education by promoting a

comprehensive understanding of how environmental, social, and economic factors are interconnected, as emphasized by the Sustainable Development Goals (SDGs).

The United Nations SDGs adopted in 2015, present an ambitious and comprehensive blueprint for global development. Woven into the fabric of these goals is recognition that environmental sustainability, social equity, and economic prosperity are intrinsically linked. Addressing these interconnected aspects requires a departure from traditional soloed educational approaches, encouraging the adoption of cross-disciplinary methodologies. This paper seeks to delve into the nuances of Liberia's biology curriculum, scrutinizing the extent to which it incorporates cross-disciplinary approaches to illuminate the intricate relationships between environmental, social, and economic elements in alignment with the SDGs.

Liberia, a nation that has endured the challenges of civil conflict and emerged into an era of reconstruction, places a premium on education as a key driver of national development. With the acknowledgment that the well-being of the nation is inextricably tied to the health of its ecosystems, social fabric, and economic structures, the biology curriculum has a crucial role in influencing the worldview and educational foundation of the nation's future citizens. The question arises: To what extent does Liberia's biology curriculum transcend traditional disciplinary boundaries to embrace a more interconnected, holistic understanding of the world?

To embark on this exploration, it is imperative to examine the foundational principles underpinning the biology curriculum in Liberia. What are the key learning objectives, and how do they align with the goals and targets articulated in the SDGs? Are there clear mentions of the interdependence among environmental, social, and economic dimensions? Or does the curriculum primarily dwell on isolated biological concepts? Additionally, a critical analysis of the instructional methodologies employed is essential to gauge the degree to which cross-disciplinary approaches are integrated into the teaching and learning processes.

Beyond the examination of curriculum documents, it is equally important to consider the implementation of the biology curriculum in actual classrooms. How do educators interpret and deliver the curriculum? Are there opportunities for students to engage in hands-on, experiential learning that transcends the boundaries of traditional disciplines? Moreover, the role of educational resources, including textbooks, laboratory materials, and digital platforms, in

facilitating cross-disciplinary exploration should be scrutinized to identify potential gaps or strengths.

This inquiry into the interplay between Liberia's biology curriculum and the SDGs necessitates a nuanced understanding of the cultural, societal, and economic contexts that shape educational policies and practices. By unraveling the intricacies of Liberia's approach to biology education, this exploration seeks not only to evaluate the current state of affairs but also to provide insights and recommendations for fostering a curriculum that prepares students to navigate the interconnected challenges of the 21st century. In doing so, Liberia has the opportunity not only to enrich the educational experience of its youth but also to contribute meaningfully to the global pursuit of sustainable development.

4. **Are there any gaps within the biology curriculum of Liberia that need enhancement to better address the SDGs, and if so, what are they?**

The convergence of education and sustainable development is a crucial junction, and it is imperative to evaluate the alignment of academic curricula with the Sustainable Development Goals (SDGs) to ensure comprehensive and effective learning outcomes. In the context of Liberia, a West African nation with a rich cultural heritage and a history marked by challenges such as civil conflict and economic instability, the spotlight on education becomes particularly significant. Among the various subjects that play a pivotal role in shaping an individual's understanding of the world, biology holds a unique position due to its intrinsic connection with life sciences and environmental sustainability. As we embark on an exploration of the gaps or areas within the biology curriculum of Liberia, it is essential to assess how well it equips students to contribute meaningfully to the achievement of the SDGs.

Liberia, like many other nations, has committed to achieving the 17 SDGs, ranging from eradicating poverty to promoting environmental sustainability. These global objectives necessitate a multidisciplinary approach, and biology, being a foundational science, should ideally provide students with the knowledge and skills required to address these challenges. However, the effectiveness of the biology curriculum in Liberia in this regard merits careful examination.

One immediate consideration is the scope and depth of coverage within the biology curriculum concerning environmental issues. The SDGs, particularly Goal 13 (Climate Action) and Goal 15 (Life on Land), emphasize the importance of biodiversity conservation, sustainable land management, and combating climate change. Analyzing whether the current biology curriculum sufficiently delves into these topics or if there is a need for enhancement becomes crucial. The curriculum should be reviewed to ensure that it effectively covers health-related biological concepts such as illness prevention, nutrition, and healthcare access in conformity with Goal 3 (Good Health and Well-being).

Furthermore, the integration of modern technologies and contemporary scientific advancements within the biology curriculum is another area worthy of exploration. Given the rapid pace of technological innovation and its profound impact on the biological sciences, it is essential to assess whether the curriculum is keeping pace with these developments. Incorporating cutting-edge topics such as biotechnology, genomics, and bioinformatics could empower students with skills that are not only relevant to the global scientific community but also instrumental in addressing health, environmental, and agricultural challenges – all of which are integral to the SDGs.

Inclusivity is a critical aspect of any curriculum, and it is imperative to evaluate whether the current biology syllabus in Liberia is accessible to students across diverse backgrounds, including those in rural areas with limited resources. Ensuring that the curriculum is designed to cater to a variety of learning environments can contribute to a more equitable distribution of knowledge and empower a broader spectrum of individuals to actively participate in sustainable development initiatives.

In conclusion, this examination of the biology curriculum in Liberia with respect to the SDGs underscores the importance of aligning education with the pressing global challenges of our time. Through a comprehensive evaluation of the curriculum's coverage of environmental issues, technological advancements, health-related concepts, and inclusivity, we can identify potential gaps that, if addressed, could enhance the curriculum's efficacy in preparing students to contribute meaningfully to the achievement of the SDGs. As we delve into the specifics of each aspect, a nuanced understanding of the strengths and limitations of the current biology

curriculum in Liberia will emerge, providing a foundation for targeted enhancements that align with the nation's commitment to sustainable development.

Discussion

A total of 181 course goals are included in the Liberian National High School Biology Curriculum, according to the conclusions that were derived from the data that was obtained from the biology curriculum of Liberia. The tenth grade is the grade in which students achieve the least amount of success, despite the fact that during the twelfth grade, students achieve the greatest number of objectives. At the twelfth-grade level, there was a maximum of eleven objectives that were associated with education on sustainable development. The tenth-grade level had the lowest number of goals that were recognized.

The fourteen objectives that is included in the Liberia National High School Biology Curriculum and come together to form the environmental component of Sustainable Development. There are two objectives that relate to the tenth grade, five goals that pertain to the eleventh grade, and seven goals that pertain to the twelve grades. As for the economic component of the SD curriculum, there are thirteen objectives that students should strive to achieve. Two students from the tenth grade, three students from the eleventh grade, and eight students from the twelve grades are included in this group. In conclusion, there are fifteen objectives that are connected to the social component of SD. This group consists of seven students in the tenth grade, five students in the eighth grade, and the third grader.

Every single one of the five units that are covered in the tenth grade does not include any ESD-related objectives. In addition, the eleventh grade is comprised of five units, however only four of those units have objectives that are concerning ESD. There are five units that make up the curriculum for the 12th grade; however, only three of those units feature objectives that are relevant to ESD.

In the pursuit of fostering a globally sustainable future, nations around the world are increasingly recognizing the pivotal role education plays in shaping environmentally conscious citizens. Liberia, situated on the west coast of Africa, stands at the forefront of this transformative movement, as it reevaluates and refines its educational frameworks to align with to the SDGs,

which are the UN's Sustainable Development Goals. Within this broader educational landscape, the biology curriculum emerges as a crucial focal point, holding the potential to shape the perspectives and actions of the next generation towards sustainable living.

Liberia's commitment to the SDGs is evident in its national development agenda, where economic growth, social justice, and environmental preservation all coexist together. As a key component of this larger strategy, the biology curriculum serves as a conduit through which foundational knowledge and values are imparted to Liberian students. This discussion aims to delve into the findings of Liberia's biology curriculum, dissecting its components, and assessing the extent to which it aligns with the SDGs.

Liberia's biology curriculum serves as the cornerstone for imparting scientific knowledge to its students. It covers a broad spectrum, ranging from fundamental biological principles to more advanced topics such as genetics, ecology, and environmental science. By analyzing the foundational elements of the curriculum, we can gain insights into the extent to which it lays the groundwork for fostering a holistic understanding of the interconnections between living organisms and their environments.

An integral aspect of this exploration involves scrutinizing the biology curriculum's integration of the SDGs. How explicitly are the goals incorporated into the learning objectives, teaching methodologies, and assessment criteria? The analysis will shed light on whether the curriculum explicitly addresses issues such as biodiversity conservation, climate change mitigation, and ecosystem preservation – all of which are critical components of the SDGs. The effectiveness of any curriculum lies not only in its theoretical foundation but also in its ability to translate knowledge into action. This segment of the discussion will evaluate how Liberia's biology curriculum encourages students to apply their understanding of biological concepts to real-world scenarios.

Sustainable development is inherently interdisciplinary, requiring collaborative efforts across various fields. This section will explore whether Liberia's biology curriculum takes a cross-disciplinary approach, integrating concepts from other disciplines such as geography, economics, and social sciences. By doing so, over the course of study, students might get a deeper appreciation for the interdependencies of biological systems with broader societal and environmental contexts.

An essential factor influencing the successful implementation of any curriculum is the accessible resources and the quality of the educational system. This part of the discussion will analyze whether Liberia's education system is adequately equipped to support the effective delivery of the biology curriculum in a manner that aligns with the principles of the SDGs.

Finally, acknowledging the complexities of curriculum development and implementation, this discussion will delve into the challenges faced by Liberia in aligning its biology curriculum with the SDGs. Conversely, it will also identify opportunities for improvement and innovation, suggesting ways in which the curriculum can be enhanced to better prepare students for active participation in sustainable development initiatives. As Liberia strives to build a resilient and sustainable future, the findings of this analysis will contribute valuable insights to the ongoing dialogue on the role of education in achieving the SDGs. By critically examining the biology curriculum, we can identify areas of strength and areas that require attention, facilitating informed discussions and informed decision-making for the continuous improvement of Liberia's educational system.

CHAPTER V

Conclusion and Recommendations

Conclusion

In the 21st century, the world is confronted with an unparalleled challenge: attaining sustainable development to secure the welfare of present and future generations. Sustainable development, according to the United Nations, is the practice of fulfilling current demands without jeopardizing the capacity of future generations to fulfill their own needs. At the heart of this ambitious endeavor lie the sustainable development and the complex link between the two fields of biology education. Biology, as the scientific study of living organisms, ecosystems, and the intricate web of life, plays a pivotal role in shaping our understanding of the natural world and our place within it. Biology education plays a vital role in developing the information, skills, and attitudes needed for people to make significant contributions to sustainable development.

The interconnectedness of biological systems underscores the importance of incorporating a comprehensive biology curriculum that goes beyond the traditional memorization of facts and embraces a holistic understanding of life on Earth. This introduction seeks to explore the multifaceted ways in which biology education contributes to sustainable development, encompassing environmental conservation, ecological resilience, human health, and ethical considerations.

At its core, biology education is essential for developing environmental literacy, providing students with the understanding to grasp the intricate equilibrium of ecosystems and the influence of human actions on biodiversity. A well-rounded biology curriculum not only imparts knowledge about the diversity of life forms but also delves into the intricate relationships between species, the functioning of ecosystems, and the critical role of biodiversity in maintaining ecological balance. As students delve into topics such as ecosystem dynamics,

climate change, and conservation biology, they gain a profound appreciation for the intricate tapestry of life and the delicate equilibrium that sustains it.

Moreover, biology education instills a sense of environmental stewardship by fostering an awareness of the anthropogenic threats to ecosystems. By delving into the consequences of deforestation, pollution, and overexploitation of natural resources, students develop a heightened sense of responsibility towards the environment. Armed with this awareness, individuals are better equipped to make informed decisions that contribute to sustainable practices, whether in their personal lives or as professionals in various fields.

The intersection of biology education and sustainable development extends beyond ecological considerations to encompass the pivotal role of biological sciences in addressing global challenges related to human health. With the emergence of infectious diseases, antibiotic resistance, and the impact of lifestyle choices on well-being, biology education becomes a cornerstone for promoting public health literacy. Students immersed in a robust biology curriculum gain insights into the intricacies of the human body, the factors influencing health, and the role of genetics in disease susceptibility. This knowledge empowers individuals to make informed decisions about their health, understand the importance of preventive measures, and contribute to public health initiatives.

Furthermore, the ethical dimensions of biology education are integral to nurturing responsible citizens who can critically assess the ethical implications of scientific advancements. Issues such as genetic engineering, biotechnology, and medical ethics necessitate a nuanced understanding of the ethical considerations surrounding the application of biological knowledge. By incorporating discussions on bioethics within the curriculum, biology education encourages students to reflect on the ethical implications of scientific research and technology, fostering a sense of responsibility and ethical decision-making in the realm of biological sciences.

Biology education has a crucial and diverse role in sustainable development. Through a comprehensive and holistic approach to biological sciences, education becomes a powerful tool for shaping environmentally conscious individuals who can contribute to the global effort for sustainable development. As we navigate the complexities of the modern world, biology education stands as a beacon, illuminating the path toward a harmonious coexistence between humanity and the natural world.

The curriculum is the bedrock of any educational system, serving as a guiding framework that shapes the intellectual and cognitive development of students. In the context of Liberia, a nation marked by a rich cultural tapestry and a commitment to rebuilding its educational infrastructure after years of civil unrest, the Biology curriculum emerges as a cornerstone in fostering scientific literacy and nurturing the next generation of scientifically adept citizens.

The Biology curriculum in Liberia plays a significant role in shaping the educational landscape, offering a comprehensive understanding of life sciences that extends beyond the confines of the classroom. As the country aims for socioeconomic progress, the significance of a strong biology curriculum is becoming more evident in preparing a workforce with the expertise and abilities needed to tackle current difficulties.

The Biology curriculum in Liberia is designed to cultivate scientific literacy, enabling students to comprehend the fundamental principles governing living organisms and their interplay within ecosystems. By emphasizing critical thinking and analytical skills, the curriculum encourages students to explore the intricacies of biological concepts, fostering a mindset that is essential for problem-solving and decision-making in various facets of life.

Liberia, endowed with diverse ecosystems ranging from lush rainforests to coastal regions, is acutely aware of the need for environmental conservation. The Biology curriculum places a strong emphasis on ecological principles, biodiversity, and conservation, instilling in students a sense of responsibility towards the environment. This holistic approach not only contributes to the nation's ecological sustainability but also nurtures a generation of environmentally conscious citizens.

The Biology curriculum serves as a platform for imparting essential knowledge about the human body, diseases, and public health. With the prevalence of health challenges in Liberia, including infectious diseases and malnutrition, the curriculum becomes a crucial tool in equipping students with the understanding and skills necessary to contribute to healthcare initiatives. It lays the foundation for future healthcare professionals, researchers, and policymakers, fostering a healthier and more resilient society.

In an era marked by rapid technological advancements, the Biology curriculum in Liberia recognizes the importance of biotechnology. It introduces students to cutting-edge developments

in genetics, molecular biology, and bioinformatics, preparing them for careers in fields such as medicine, agriculture, and biopharmaceuticals. This forward-looking approach ensures that Liberian students are well-positioned to contribute to and benefit from the global biotechnological landscape.

The Biology curriculum in Liberia is not solely confined to theoretical knowledge; it is designed to be culturally relevant and applicable to the daily lives of students. By incorporating local examples, indigenous knowledge, and community-based projects, the curriculum fosters a sense of ownership and connection among students. This approach not only enhances the learning experience but also promotes community engagement and encourages students to explore the intersection of biology with their cultural heritage.

The Biology curriculum in Liberia emerges as a dynamic and multifaceted tool that goes beyond the transmission of scientific knowledge. It acts as a catalyst for holistic development, empowering students to become active contributors to societal progress, environmental sustainability, and scientific innovation. As Liberia continues its journey towards educational revitalization, the Biology curriculum stands as a testament to the nation's commitment to nurturing a scientifically literate and socially responsible citizenry.

Education serves as the cornerstone of national development, Equipping people with the information and skills necessary to succeed in a swiftly evolving world. In the pursuit of sustainable development, countries around the globe are recognizing the pivotal role of an enriched and contextually relevant curriculum. Liberia, nestled on the west coast of Africa, is no exception to this paradigm shift. As Liberia sets its sights on sustainable development, the biology curriculum emerges as a critical instrument in shaping the future of the nation.

The Liberia biology curriculum, designed to align with the country's unique socio-economic and environmental context, holds immense potential to drive sustainable development. Tailored to the needs and challenges faced by Liberia, the curriculum serves as a vehicle to empower its youth with scientific knowledge, critical thinking skills, and a deep understanding of the interplay between biological systems and sustainable practices. This introduction explores the multifaceted benefits that the Liberia biology curriculum can offer in fostering a bright future for the nation.

The biology curriculum plays a vital role in fostering scientific curiosity and inquiry among Liberia's students. By introducing foundational concepts of biology, such as genetics, ecology, and evolution, students are equipped with the tools to analyze and understand the complexities of the natural world. This scientific literacy not only enriches their academic experience but also lays the groundwork for informed decision-making in the realms of agriculture, healthcare, and environmental stewardship.

Liberia boasts a rich and diverse ecosystem, making it imperative to instill a sense of environmental responsibility in its citizens. The biology curriculum is strategically positioned to nurture an understanding of biodiversity, ecological balance, and the environmental effects of human activities. Through experiential learning practical applications, students can develop a profound appreciation for Liberia's natural resources and learn how to contribute to conservation efforts, thus aligning with the nation's commitment to sustainable environmental practices.

Agriculture stands as a cornerstone of Liberia's economy, providing livelihoods for a significant portion of the population. The biology curriculum, by emphasizing agricultural biology and sustainable farming practices, provides pupils with the necessary knowledge and abilities to increase agricultural productivity. This not only contributes to food security but also fosters economic empowerment at both individual and community levels, aligning with Liberia's broader sustainable development goals.

A robust biology curriculum is integral to addressing health challenges faced by Liberia. By delving into topics such as anatomy, physiology, and disease prevention, students gain insights into public health issues and learn how to make informed decisions for personal and community well-being. This knowledge serves as a foundation for healthcare professionals, community health workers, and informed citizens who can actively contribute to Liberia's healthcare infrastructure and overall societal wellness.

The Liberia biology curriculum extends beyond national boundaries, nurturing global citizens who understand their interconnectedness with the broader world. By exploring topics related to global ecosystems, climate change, and sustainable development, students develop a sense of responsibility and awareness that transcends borders. This global perspective positions Liberia as an active participant in international efforts to address shared challenges and promotes responsible global citizenship.

The potential benefits of the Liberia biology curriculum for sustainable development are vast and varied. By cultivating scientific inquiry, fostering environmental stewardship, empowering through agriculture, promoting health and well-being, and instilling a sense of global citizenship, the curriculum emerges as a powerful catalyst for positive change By wholeheartedly embracing the prospects that its biology curriculum presents, Liberia establishes the groundwork for a sustainable future by preparing the nation's children to address 21st-century issues with knowledge, resilience, and a dedication to sustainable behaviors.

In pursuance of sustainable development, the Sustainable Development Goals (SDGs) were established by the United Nations as a global appeal to eliminate poverty, protect the environment, and ensure prosperity for all by 2030. Liberia, a nation on the west coast of Africa, has embraced this global initiative with the aim of transforming its socio-economic landscape. While the SDGs encompass a wide range of objectives, the role of education, particularly biology education, stands out as a crucial pillar in achieving these goals. However, the implementation of SDGs through biology education in Liberia is fraught with a myriad of challenges that require thoughtful consideration and strategic solutions.

Liberia, emerging from the shadows of a protracted civil war that spanned from 1989 to 2003, faces multifaceted challenges in its efforts to rebuild and develop sustainably. The importance of biology education in this context cannot be overstated, It is closely connected to important Sustainable Development Goals (SDGs) including excellent health and well-being (SDG 3), quality education (SDG 4), and life on land and below water (SDGs 15 and 14).Despite the pivotal role that biology education plays in achieving these goals, numerous hurdles hinder its effective implementation.

One of the foremost challenges is the inadequate infrastructure and resources in Liberia's education system. Insufficient laboratories, outdated textbooks, and a lack of modern teaching aids hamper the quality of biology education. This impediment not only affects the understanding and appreciation of biological concepts among students but also constrains educators in delivering

comprehensive and interesting classes that adhere to sustainable development concepts.

Furthermore, these shortage of qualified biology teachers exacerbates the situation. The aftermath of the civil war resulted in a brain drain, with many skilled educators leaving the country. The dearth of experienced biology instructors not only hampers the delivery of quality education but also limits the mentorship and guidance essential for nurturing the next generation of environmentally conscious citizens.

Another significant challenge lies in the prevailing socio-economic disparities in Liberia. Many students face barriers to education due to poverty, with families unable to afford basic schooling materials and uniforms. Economic disparity leads to a high dropout rate, particularly among girls, which perpetuates a cycle of ignorance and hinders progress towards the Sustainable Development Goals (SDGs). Implementing effective biology education programs necessitates addressing these socio-economic disparities to ensure inclusivity and equal access to educational opportunities.

Moreover, the lack of awareness and understanding of the interconnections between biology education and sustainable development poses a considerable challenge. While the SDGs underscore the importance of education in fostering a global citizenship mindset, the intricate linkages between biological sciences and sustainable development are often overlooked. Bridging this gap requires concerted efforts in curriculum development and efforts to raise awareness about the significance of biology education in attaining sustainable development in Liberia.

In conclusion, this journey towards implementing the SDGs through biology education in Liberia is fraught with challenges that demand immediate attention

and strategic solutions. Addressing infrastructure deficiencies, overcoming the shortage of qualified teachers, tackling socio-economic disparities, and enhancing awareness of the pivotal role of biology education are imperative steps in building a sustainable future for Liberia. As the nation grapples with these challenges, a collaborative and concerted effort from policymakers, educators, and the wider community is essential to pave the way for a more garble educational system

Recommendations According to Findings

The Liberia biology curriculum play a meaningful role in achieving Sustainable Development Goals (SDGs) is paramount in shaping a future where environmental, economic, and social challenges are addressed comprehensively. This recommendation is based on a comprehensive analysis of the current biology curriculum in Liberia, considering its alignment with the SDGs and proposing strategic reforms to better integrate sustainable development principles.

1. **Overview of the Current Biology Curriculum:**

The existing Liberia biology curriculum serves as the foundation for scientific education in the country. However, a critical evaluation reveals a need for greater emphasis on sustainable development concepts. While the curriculum covers fundamental biological principles, it lacks explicit connections to real-world challenges, hindering the development of a holistic understanding of environmental issues and their implications for sustainable development.

2. **Alignment with Sustainable Development Goals:**

The seventeen SDGs established a comprehensive framework to tackle worldwide challenges. A comprehensive examination uncovers that the existing biology curriculum in Liberia fails to sufficiently cover a number of critical facets of the Sustainable Development Goals (SDGs), specifically those pertaining to health, environmental preservation, biodiversity, climate change, and health.

3. Recommendations for Curriculum Reforms:

a. Integration of Concepts of Sustainable Development: To ensure that students have a solid understanding of the interconnection of environmental, social, and economic systems, the curriculum should contain the essential principles of the Sustainable Development Goals (SDG). The development of modules that are especially geared toward the protection of biodiversity, the reduction of harmful effects of climate change, and the administration of green resources.

b. Cross-Disciplinary Approach: Facilitating interdisciplinary cooperation between the fields of biology and economics, sociology, and geography in order to furnish students with a comprehensive comprehension of sustainability challenges from multiple perspectives. Promoting interdisciplinary endeavors that tackle tangible challenges of existence, thereby cultivating aptitudes for critical analysis and resolution.

c. Practical Application and Fieldwork: Enhancing the curriculum with hands-on experiences, field trips, and case studies to connect theoretical knowledge with practical applications.

Collaborating with local environmental organizations and research institutions to expose students to ongoing sustainability projects and initiatives.

d. Community Engagement: Incorporating community-based projects into the curriculum to encourage students to actively contribute to local sustainable development efforts.

In the context of the local environment, raising awareness of the social and economic ramifications of sustainable practices is an important step.

e. Teacher Training and Professional Development: Providing teachers with specialized training in sustainable development education.

Supporting ongoing professional development to ensure educators stay informed about emerging issues and best practices in the field.

4. **Monitoring and Evaluation:**

- Establishing a robust system for monitoring the effectiveness of curriculum reforms in achieving sustainability learning outcomes.

- Periodic evaluations and feedback mechanisms to make continuous improvements based on evolving global and local sustainability challenges.

5. **Resource Mobilization and Partnerships:**

- Collaborating with international organizations, NGOs, and private sector entities to secure resources for curriculum development, teacher training, and infrastructure improvement.
- Leveraging partnerships to enhance the curriculum's relevance to global sustainability initiatives.

In conclusion, the proposed recommendations aim to transform the Liberia biology curriculum into a powerful tool for fostering a generation of environmentally conscious and socially responsible citizens. Liberia has the potential to make a substantial contribution to international endeavors aimed at sustainable development and foster a more equitable and resilient future for its populace by harmonizing its educational practices with the SDGs.

Recommendations for Further Research

It is sad that the curriculum's limited and poor explanations prevented many accomplishments from being included in any dimension, even though they could be readily connected with education for sustainable development. The only thing this research does is look at the biology course material. Given that the literature review section delves into the history of sustainable development, it would be beneficial to analyze the curricula that have been implemented from different time periods. This will offer valuable insights into the field of sustainable development education, including any shortcomings or advancements that may have occurred. This data will be useful for curriculum developers. Biology, chemistry, and physics are the three branches of science studied in high school. In the link of SDGs, it will be more comprehensive to examine the chemistry and physics course syllabi in order to draw conclusions under the Science heading and to plan for future improvements and corrections. The research indicates that various levels exhibit distinct distributions of sustainable development traits and materials related to education for sustainable development, with certain units consistently excluding these issues. Taking into account the subject matter and ESD goals of the appropriate levels, curriculum writers should fix these deficiencies holistically. The research does not extend beyond its examination of the

biology course material, as stated in the study's limitations. Having said that, there are a plethora of training and education materials that are topic books developed with biological aims in mind. Curriculum writers working on sustainable development education can benefit from content analysis in this area as they work to enhance and expand the field's curricula. Curriculum content analyses alone cannot produce responsible citizens with a keen understanding of sustainable development. The incorporation of sustainability concepts into the learning environment is just as vital as the curriculum material in molding students' knowledge and comprehension.

References

Alam, A. (2021, December). Notice of Retraction: Designing XR into Higher Education using Immersive Learning Environments (ILEs) and Hybrid Education for Innovation in HEIs to attract UN's Education for Sustainable Development (ESD) Initiative. In 2021 International Conference on Advances in Computing, Communication, and Control (ICAC3) (pp. 1-9). IEEE.

Alvino, F., Di Vaio, A., Hassan, R., & Palladino, R. (2021). Intellectual capital and sustainable development: A systematic literature review. Journal of Intellectual Capital, 22(1), 76-94.

Ashby, M. F. (2022). Materials and sustainable development. Butterworth-Heinemann.

Baena-Morales, S., & González-Víllora, S. (2023). Physical education for sustainable development goals: Reflections and comments for contribution in the educational framework. Sport, Education and Society, 28(6), 697-713.

Bali Swain, R., & Yang-Wallentin, F. (2020). Achieving sustainable development goals: predicaments and strategies. International Journal of Sustainable Development & World Ecology, 27(2), 96-106.

Becker, P. (2023). Sustainability science: Managing risk and resilience for sustainable development. Elsevier.

Bizimana, E., Mutangana, D., & Mwesigye, A. (2021). Performance analysis of biology education under the implementation of lower secondary school biology-competence-based curriculum: Policy implications. Interdisciplinary Journal of Environmental and Science Education, 18(1), e2259.

Burbules, N. C., Fan, G., & Repp, P. (2020). Five trends of education and technology in a sustainable future. Geography and Sustainability, 1(2), 93-97.

Caradonna, J. L. (2022). Sustainability: A history. Oxford University Press.

Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in education for sustainable development: Emerging teaching and research developments. Sustainability, 12(2), 579.

Chankseliani, M., & McCowan, T. (2021). Higher education and the sustainable development goals. Higher Education, 81(1), 1-8.

Cheng, Z., Wang, H., Xiong, W., Zhu, D., & Cheng, L. (2021). Public–private partnership as a driver of sustainable development: Toward a conceptual framework of sustainability-oriented PPP. Environment, Development and Sustainability, 23, 1043-1063.

Corsi, A., Pagani, R. N., & Kovaleski, J. L. (2020). Technology transfer for sustainable development: Social impacts depicted and some other answers to a few questions. Journal of Cleaner Production, 245, 118522.

Davis, J., & Elliott, S. (Eds.). (2023). Young children and the environment: Early education for sustainability. Cambridge University Press.

de Vries, H., Donner, M., & Axelos, M. (2021). A new conceptual 'cylinder'framework for sustainable bioeconomy systems and their actors. Journal of agricultural and environmental ethics, 34, 1-26.

Dogan, O. K. (2021). Methodological? Or dialectical?: Reflections of scientific inquiry in biology textbooks. International Journal of Science and Mathematics Education, 19(8), 1563-1585.

Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., ... & Gingrich, S. (2020). The Sustainable Development Goals prioritize economic growth over sustainable resource use: a critical reflection on the SDGs from a socio-ecological perspective. Sustainability Science, 15, 1101-1110.

Erstad, O., Kjällander, S., & Järvelä, S. (2021). Facing the challenges of 'digital competence' a Nordic agenda for curriculum development for the 21st century. Nordic Journal of Digital Literacy, 16(2), 77-87.

Fonseca, L. M., Domingues, J. P., & Dima, A. M. (2020). Mapping the sustainable development goals relationships. Sustainability, 12(8), 3359.

Fuchs, C. (2021). Critical social theory and sustainable development: The role of class, capitalism and domination in a dialectical analysis of un/sustainability. In Foundations of Critical Theory (pp. 131-155). Routledge.

Giesenbauer, B., & Müller-Christ, G. (2020). University 4.0: Promoting the transformation of higher education institutions toward sustainable development. Sustainability, 12(8), 3371.

Hackman, S. T., Zhang, D., & He, J. (2021). Secondary school science teachers' attitudes towards STEM education in Liberia. International Journal of Science Education, 43(2), 223-246.

Hogan, D., & O'Flaherty, J. (2021). Addressing education for sustainable development in the teaching of science: The case of a biological sciences teacher education program. Sustainability, 13(21), 12028.

Ikram, M., Zhang, Q., Sroufe, R., & Ferasso, M. (2020). The social dimensions of corporate sustainability: an integrative framework including COVID-19 insights. Sustainability, 12(20), 8747.

Janker, J., & Mann, S. (2020). Understanding the social dimension of sustainability in agriculture: a critical review of sustainability assessment tools. Environment, Development and Sustainability, 22(3), 1671-1691.

Jappah, J. V., & Smith, D. T. (2022). Teacher training as a key component of educational investment and human development in postconflict Liberia. Africa Today, 68(3), 45-63.

Jeronen, E. (2020). Sustainable development. In Encyclopedia of Sustainable Management (pp. 1-7). Cham: Springer International Publishing.

Kakupa, P., & Shayo, H. J. (2021). Implementing Sustainable Development Goal on Education (SDG4) amid Donor Fatigue: Challenges for the Global South. Advances in Social Sciences Research Journal, 8(11), 20-28.

Khan, H. H., Malik, M. N., Zafar, R., Goni, F. A., Chofreh, A. G., Klemeš, J. J., & Alotaibi, Y. (2020). Challenges for sustainable smart city development: A conceptual framework. Sustainable Development, 28(5), 1507-1518.

Kirkby, J., O'Keefe, P., & Timberlake, L. (Eds.). (2023). The Earthscan reader in sustainable development. Taylor & Francis.

Kopnina, H. (2020). Education for the future? Critical evaluation of education for sustainable development goals. The Journal of Environmental Education, 51(4), 280-291.

Kyngäs, H. (2020). Inductive content analysis. The application of content analysis in nursing science research, 13-21.

Lee, K. H., Noh, J., & Khim, J. S. (2020). The Blue Economy and the United Nations' sustainable development goals: Challenges and opportunities. Environment international, 137, 105528.

Lindgren, B. M., Lundman, B., & Graneheim, U. H. (2020). Abstraction and interpretation during the qualitative content analysis process. International journal of nursing studies, 108, 103632.

Mondejar, M. E., Avtar, R., Diaz, H. L. B., Dubey, R. K., Esteban, J., Gómez-Morales, A., ... & Garcia-Segura, S. (2021). Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet. Science of The Total Environment, 794, 148539.

Nousheen, A., Zai, S. A. Y., Waseem, M., & Khan, S. A. (2020). Education for sustainable development (ESD): Effects of sustainability education on pre-service teachers' attitude towards sustainable development (SD). Journal of Cleaner Production, 250, 119537.

Novidsa, I., Purwianingsih, W., & Riandi, R. (2020). Exploring knowledge of prospective biology teacher about education for sustainable development. JPBI (Jurnal Pendidikan Biologi Indonesia), 6(2), 317-326.

Nsengimana, T., Rugema Mugabo, L., Hiroaki, O., & Nkundabakura, P. (2020). Reflection on science competence-based curriculum implementation in Sub-Saharan African countries. International Journal of Science Education, Part B, 1-14.

Nussey, C., & Rigon, A. (2019). Bringing Agenda 2030 to Life. Liberia Sustainable Development Report.

Roorda, N. (2020). Fundamentals of sustainable development. Routledge.

Roosa, S. A. (2020). Sustainable development handbook. CRC Press.

Ruggerio, C. A. (2021). Sustainability and sustainable development: A review of principles and definitions. Science of the Total Environment, 786, 147481.

Sánchez-Pardo, E., & Sánchez, M. P. (Eds.). (2023). Myth and Environmentalism: Arts of Resilience for a Damaged Planet. Taylor & Francis.

Scharlemann, J. P., Brock, R. C., Balfour, N., Brown, C., Burgess, N. D., Guth, M. K., ... & Kapos, V. (2020). Towards understanding interactions between Sustainable Development Goals: The role of environment–human linkages. Sustainability Science, 15, 1573-1584.

Shutaleva, A., Nikonova, Z., Savchenko, I., & Martyushev, N. (2020). Environmental education for sustainable development in Russia. Sustainability, 12(18), 7742.

Singh, R. L., & Singh, P. K. (2017). Global environmental problems. Principles and applications of environmental biotechnology for a sustainable future, 13-41.

Sisuse, K. (2023). Education for Sustainable Development: A Solution to Reduce Food Insecurities in Liberia.

Sund, P., & Gericke, N. (2020). Teaching contributions from secondary school subject areas to education for sustainable development–a comparative study of science, social science and language teachers. Environmental Education Research, 26(6), 772-794.

Taimur, S., & Sattar, H. (2020). Education for sustainable development and critical thinking competency. Quality education, 238-248.

teachers' challenges. Teachers and Teaching, 28(7), 859-874.

Teixeira, J. G., Gallan, A. S., & Wilson, H. N. (2023). SDG commentary: service ecosystems with the planet-weaving the environmental SDGs with human services. Journal of Services Marketing.

Tsalis, T. A., Malamateniou, K. E., Koulouriotis, D., & Nikolaou, I. E. (2020). New challenges for corporate sustainability reporting: United Nations' 2030 Agenda for sustainable development and the sustainable development goals. Corporate Social Responsibility and Environmental Management, 27(4), 1617-1629.

Uralovich, K. S., Toshmamatovich, T. U., Kubayevich, K. F., Sapaev, I. B., Saylaubaevna, S. S., Beknazarova, Z. F., & Khurramov, A. (2023). A primary factor in sustainable development and environmental sustainability is environmental education. Caspian Journal of Environmental Sciences, 21(4), 965-975.

Wamsler, C. (2020). Education for sustainability: Fostering a more conscious society and transformation towards sustainability. International Journal of Sustainability in Higher Education, 21(1), 112-130.

Wehye, B. Y. (2021) Suggested National Teacher Education Curriculum for Liberia.

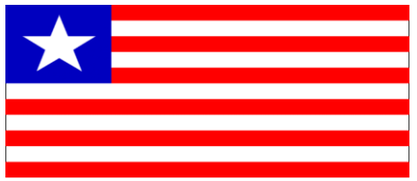
Wehye, B. Y. (2023). ADDRESSING THE INPUT-OUTCOME GAPS IN EDUCATIONAL POLICIES: CASE STUDY OF LIBERIA.

Zakari, A., Khan, I., Tan, D., Alvarado, R., & Dagar, V. (2022). Energy efficiency and sustainable development goals (SDGs). Energy, 239, 122365.

Zhang, T., Shaikh, Z. A., Yumashev, A. V., & Chłąd, M. (2020). Applied model of E-learning in the framework of education for sustainable development. Sustainability, 12(16), 6420.

Appendices

Appendix A



REPUBLIC OF LIBERIA

MINISTRY OF EDUCATION

NATIONAL CURRICULUM FOR GRADES 10 TO 12

BIOLOGY

February 2011

MESSAGE FROM THE MINISTER OF EDUCATION

I wish to extend my thanks and appreciation to ECSEL, UNESCO and all our partners for their immense contribution to this important task of revising and strengthening of the National Curriculum. Special thanks to USAID through LTTP for their funding and technical support in the harmonization or realignment of the curriculum. We extend sincere thanks and appreciation to the Bureau of Curriculum Development and Textbook Research, the National Curriculum Taskforce, and the subject specialists from various institutions for the level of professionalism that went into this exercise.

The revision and strengthening of our National Curriculum comes at a time when our nation is faced with the Herculean task or challenge of education transformation, national reconstruction, recovery and renewal in the aftermath of a devastating civil war. Hence, critical to this national challenge is the rebuilding of the education sector as Liberians can not achieve the desired socio-economic progress in the absence of a strong, vibrant and productive education and training system.

The revised national curriculum has two features which include the regular core subject areas of Mathematics, Science, Language Arts and Social Studies and emphasis is being given to the global challenge of HIV/AIDS, Peace, Citizenship, Human Rights and Environmental education. Secondly, the new curriculum is developed in line with international standards especially those practiced and enshrined in the curriculum of our sisterly Republic of Nigeria and Ghana who are also members of the West African Examinations Council (WAEC) .

We wish to urge all our education partners including students, teachers, principals, proprietors of schools and members of school boards to use this curriculum in our schools to enhance quality and relevant instruction and to enable our students to be adequately prepared to take the West African Senior Secondary Certificate Examinations (WASSCE) come 2013 as envisaged by us in the education sector.

May I conclude by once again saying big thank-you to all those who contributed to make this project a success.

Hon. E. Othello Gongar
MINISTER

INTRODUCTION

The senior high school revised Biology curriculum covers a biology course work over a three-year period at the 10th, 11th and 12th grade levels. The overall goal of the course of study is to enable students to demonstrate and apply knowledge of the general principles associated with the nature and continuity of living things, including basic structures of microorganisms, multicellular plants, invertebrates, vertebrate and their relationship to man.

A student-centred approach is emphasized in this curriculum. This is based on the firm belief that learning becomes more permanent, meaningful, and exciting when students themselves take ownership of the learning process. Teachers are, therefore, urged to contrive those classroom strategies that would engage students actively in the teaching/learning process.

AIMS AND OBJECTIVES

Upon the completion of this course of study, students will be able to:

1. Name and define the different branches of biology
2. State the basic principles associated with the science of life, including living conditions
3. Explain the importance of biological knowledge in our everyday living
4. Identify and analyze the problems involved in the survival of living things, and develop an appreciation of nature
5. Acquire basic scientific and intellectual skills such as observing, classifying, and interpreting data
6. Acquire adequate laboratory and field skills to carry out experiments in Biology, and conduct projects requiring the collection of primary data
7. Develop the scientific attitude of problem solving, and an acute sense of curiosity, creativity, and critical thinking

SEMESTER: ONE

PERIOD: I

GRADE: 10

TOPIC : BIOLOGY: IT'S BRANCHES; THE STUDY OF CELL AS THE BASIC UNIT OF LIFE; AND MOVEMENT OF SUBSTANCESACROSS CELL MEMBRANE

SPECIFIC OBJECTIVES:

Upon completion of this topic, students will be able to:

1. List and discuss the branches of biology
2. Name some contributors to the development of biology including
3. Describe the characteristics of living thing including reproduction
4. Describe the structure and composition of the cell and discuss their functions
5. Distinguish between the basic functions of tissues, organs and systems
6. Draw and label the parts of the light microscope
7. Demonstrate the use of the microscope in viewing specimen
8. Distinguish between Akaryotic, Prokaryotic and Eukaryotic cells
9. Outline differences between plant and animal cells
10. Discuss the movement of substances into and out of the cell

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION
Realize that all livings things are made of cells. Attain the concept that living things have specific characteristics, including reproduction, that distinguish them from nonliving things. Acquire the fundamentals of laboratory skills in biology and the use of the microscope.	• **Branches of Biology** a) Definitions of Botany, Zoology, Anatomy, Histology, Physiology, Ecology, Entomology, Cytology, Virology, Bacteriology, Microbiology, Mycology Parasitology, Endocrinology and Ichthyology. • **Biological tools** Light microscopes	1. Naming the branches of biology and explaining their interrelationships. 2. Identifying and discussing three contributors, including a Liberian, to the development of the field of biology. 3. Describing the branches of biology	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High*	• Students will be required to list the branches of biology, and briefly discuss each • Quizzes on the contributors to the development of biology • Short answer questions on: - Characteristics of living things - Composition and functions of cell - Functions of tissues, organs and system • Students should use the light microscope to observe onion

	• **Contributors:** Nationality and major contributions of: a) Aristotle b) Carolus c) Lineaus d) Louis Pasteur e) Koch f) Mendel g) Harvey h) Parlov, etc; • **Living and Non-living things:** a) processes by which living things can be distinguished from non-living things: nutrition, respiration, excretion, irritability, movement, growth and reproduction b) characteristics and examples of plants and animals c) distinguishing characteristics and examples - Euglena , a boarder organism between animals and plants • **Cell:** a) Basic structure and functions of parts of a cell. b) Movement of substances into and out of the cell: osmosis, diffusion, facilitated diffusion, active transport, endocytosis (pinocytosis, phagocytosis), and exocytosis	that give insight into STIs. 4. Describing the basic characteristics of living things including reproduction. 5. Drawing cells (animal & plant) and labeling their parts. 6. Drawing and labeling the parts of the light. Microscope and explaining their functions. 7. Identifying some laboratory materials and apparatus and stating their uses. 8. Microscope observing: a) onion skin;, b) chick cells; and c) elodea plant cells.	*Integrated Science* (Pearson, 2009) • Biological charts on branches of biology • Compound light microscopes • Onion bulbs • Tooth picks • Slides, prepared • Droppers • Razor blade • Elodea plants • Iodine solution	skin, chick cells, and elodea plant cells, and draw and label them • Practical assignments

SEMESTER: ONE

PERIOD: II

GRADE: 10

TOPIC : THE HIERACHY AND DIVERSITY OF LIVING THINGS AND UNICELLULAR ORGANISMS

SPECIFIC OBJECTIVES:

Upon completion of the topic, students will be able to:

1. Outline the diversity of living things and explain what classification (taxonomy) means
2. Discuss the basis of taxonomy
3. Discuss the basis on which living things are named/classified
4. Discuss the relationship of viruses to living and non living things
5. State the major characteristics of the kingdoms Prokaryotae (bacteria), Protista (protists), Fungi (fungi), Plantae (Plants) and Animalia (animals)
6. Draw and label a representative organism found in each kingdom
7. Classify organisms into kingdom, phylum, class, order, family, genus and species
8. State the basic characteristics of unicellular organisms
9. Draw and label ameba, paramecium, trypanosome and plasmodium
10. Describe those characteristics that qualify unicellular organisms to be considered living organisms
11. Name unicellular organisms that are causative agents of diseases and the diseases they cause

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Realize that organisms are classified systematically based on biological keys. Demonstrate knowledge of the similarities and differences among the five major kingdoms of living things.	**1. Classification of living things and the importance of this classification** **2. Organizational plan for classification (Kingdom, Phylum, Class, Order, Family, Genus and Species)** **3. Unicellular organisms** a) STI-causing agents: Fungus,	1. Selecting and classifying organisms on the basis of their characteristics and biological keys. 2. Listing the general characteristics of each kingdom. 3. Drawing and labeling a representative organism of each kingdom.	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008).	• Short answer questions on the general classification of living things with specific reference to some common West African organisms. • Students to state the causes, effects and preventions of malaria and dysentery. • Using a matching list,

Attain the concept that life evolved from the simplest to the complex forms and that in its simplest form, living things can live as independent entities.	Bacteria, Virus, Protozoa Sarcodina – ameba – disease (dysentery) - effects & prevention b) Ciliate-paramecium c) Flagellates-euglena, trypanosomes d) Sporozoa (plasmodium) Malaria: - causes, effects & prevention - myths **4. Parasitic protozoa (others)** a) Entameba histolytica - Amebic dysentery (amebiasis) b) Giardia lamblia **5. Habitats and body structure** - Life processes: a) locomotion b) feeding c) respiration d) excretion e) reproduction f) responses	4. Drawing and labeling the structures of unicellular organisms; a) Ameba b) Paramecium c) Euglena. 5. Observing unicellular organisms under a microscope by examining a drop of water containing protozoans. 6. Drawing the life cycle of plasmodium. 7. Listing and discussing causative agents of STI and diseases they cause. 8. Discussion of the effects and preventions of malaria and dysentery.	• Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Specimens or drawings of various organisms, e.g. butterfly, cockroach, snail, earthworm, cat, man, etc. • Large beaker for setting up Hays infusion • Charts on kinds of Protozoans • Compound light microscopes • Empty slides • Prepared slides • Cover slips • Chemical (protoslo)	students should be able classify the characteristics of the five kingdoms of living things • Practical assessment of drawings

SEMESTER: ONE

PERIOD: III

GRADE: 10

TOPIC : TISSUES AND MULTICELLULAR ANIMALS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Name and discuss the functions of the four types of tissues (epithelial, connective muscle and nervous)
2. Explain the concept of organ as a combination of tissues
3. Describe the characteristics of multicellular organisms
4. Describe the general characteristics of sponges
5. Describe the morphology and basic life characteristics of hydra
6. Classify worms, pointing out basic structural differences
7. Explain parasitism among the flat and roundworms, describing the life cycle and alternative hosts
8. State measures for preventing parasitic worm infections
9. Differentiate between the leech and earth worm from a morphological point of view
10. Describe the morphology, mode of nutrition, respiration, excretion and reproduction of the earth worm and its economic importance.

OUTCOMES	CONTENT	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Realize that there is division of labor amongst cells and the development of tissues as working units in multicellular animals. Appreciate the need to prevent parasitic worm diseases; and demonstrate knowledge of doing so.	**1. Tissue and Organ systems** **2. Sponges** a) Morphology b) Sessile existence c) Nutrition **d)** Respiration**.** **3. Hydra** a) morphology b) adaptation c) locomotion d) nutrition e) respiration f) response to stimuli h) Reproduction	1. Explanation of tissue in relationship to organ systems 2. Drawing and labeling the body structure of a sponge and stating the functions of each 3. Drawing the three different cells of a sponge and stating the function of each 4. Drawing and labeling the parts of a hydra	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide	• Students should name and describe the types and functions of various body tissues and organs. • With the use of charts, students should draw and label sponges, hydra, flat worms, segmented worms, ascaris, tape worms and live earth worm. • Short answer questions on: - Classification of worms - Parasitism among flat and round

	and defense. **4. Worms:** a) flat worms Planarian (free living) - blood & liver flukes - tape worms b) Parasitic round worms - ascaris - hook worm - filarial worm - trichina worm c) Segmented worms - Earth worm and leeches	and stating their functions 5. Explanation of the conditions for oral transmission to the host of any intestinal parasite. 6. Stating the effects, symptoms and methods of prevention of any intestinal parasite. 7. Dissecting an earth worm and identifying its external and Internal features. 8. Observing and drawing the external structures of: a. filarial worm b. tape worm c. hook worm d. round worm	**<u>C. Other Resources/Supplementary Readings</u>** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • charts on various types of tissues and organs • charts on various kinds of multicultural invertebrate animals including sponges, hydras, • charts on various kinds of worms ➢ flat worms, ➢ segmented worms ➢ ascaris, ➢ tape worms ➢ live earth worms ➢ hook worm ➢ filarial worm ➢ trichina worm • dissecting tray • dissecting set • gloves • beakers • water	worms - Measures to prevent parasitic worm infections - Differentiation of leech and earthworm • Practical assessment of dissections

SEMESTER: TWO

PERIOD: IV

GRADE: 10

TOPIC : ARTHROPOD AND BIOLOGICAL CONTROL OF PESTS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Discuss the general characteristics of the arthropod
2. Describe the external and internal features of the grasshoppers, weevils and cotton strainers; their mode of life, adaptation to their habitats and economicimportance
3. Explain the process of metamorphosis (complete & incomplete) in arthropods;
4. Discuss the role of cockroach, mosquito and house-fly as vectors
5. Explain the general characteristics of butterfly
6. Discuss the economics importance of the honey bees and
7. Discuss pests, their economic importance and control measures.

OUTCOMES	CONTENT	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION
Strong desire to destroy all breeding sites of arthropods that cause diseases and a realization that some arthropods can be used as food.	**1. Arthropod: general characteristics, classification with examples:** a) study specimen: grasshopper/locust or cockroach, weevils and cotton stainers b) morphology c) respiration d) mouth parts, food and feeding e) life cycle: metamorphosis (complete and incomplete) **2. Mosquitoes:** - Types, mouth parts and feeding, life cycle, transmission of plasmodia, teste fly as vector of trypanosomes, and control measure. **3. Transmission of diseases by house fly and cockroach** **4. Butterfly and moth:** - general characteristics - mouth parts and feeding **5. Honey bee** **6. Pests** - Economic importance - Chemical control - Biological control	1. Discussing the economic importance of arthropods 2. Diagramming the life cycle of mosquitoes (anopheles) in relationship to the plasmodium (malaria) 3. Collecting mosquito larvae/wigglers and bringing to the class for observation. 4. Listing methods of controlling the spread of malaria. 5. Collecting butterfly, grasshopper, cockroach, weevils, cotton strainers and fly and observing their external body structures 6. Drawing and labeling the parts of a grasshopper 7. Collecting and classifying some arthropods 8. Listing modes of transmission and methods of preventing diarrhea. 9. Stating the economic importance of honey bees 10. Discussing honey bee as social insects.	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts on various kinds of arthropods and malaria cycle • Specimens: crab, crayfish, spiders, centipede, millipede, grasshoppers, butterflies cockroaches, weevils and cotton stainers • Insect collecting net • Dissecting set • Dissecting tray	• Collection and classification of arthropods; and discussion of the division of labor among honey bees. • Quizzes for students to: - Discuss the role of cockroach, mosquito and house fly as vectors - Explain the general characteristics of the butterfly • Short answer questions for students to discuss: - The economic importance of the honey bee - Pests and their economic importance as well as control measures • Questions & Answers Quizzes • Assignments • Tests • Discussion

			• Gloves	

SEMESTER: TWO

PERIOD: V GRADE:

10

TOPIC : PLANT-LIKE ORGANISMS (ALGAE, FUNGI, MOSSES, FERNS) AND PHOTOSYNTHEISIS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Describe the general characteristics, structures and life cycles of algae, fungi, mosses and ferns
2. Explain the economic importance of algae and fungi to human
3. Describe the process of reproduction (sexual and asexual) in algae
4. Explain types of nutrition of fungi with terms such as *parasitic*, and *saprophytic*:
5. List common fungal diseases of plants and human such as athlete foot, ringworm dishcloth, blight
6. Explain the process of photosynthesis

OUTCOMES	CONTENT	ACTIVITIES	MATERIALS RESOURCES	EVALUATION

Realize that algae are producers of atmospheric oxygen and serve as food for marine organisms. Realize that penicillin is produced by fungus. Realize that mosses and ferns are non-flowering plants.	**1. Algae:** a) General characteristics b) classification c) phytoplankton (floating microbe) d) green algae e) Spirogyra-reproduction (sexual and asexual) f) economic importance of algae in food, medicine& industry) **2. Fungi:** a) General characteristics b) classification	1. Drawing and labeling the parts of a spirogyra 2. Drawing and labeling the stages of sexual reproduction in spirogyra 3. Examining and identifying a piece of molded bread under the microscope showing the hyphae of rhizopus,; drawing and labeling	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000)	• With the aid of the microscope, students should examine rhizopus, draw and label the parts. • Students explain the life cycles of mosses and ferns in short essays • Short answer questions for students to: - Describe the process of

	c) nutrition-parasitic, saprophytic d) diseases of plants & human, blight, smuts, rust, athletes foot, yeast infection, ringworm and dishcloth. **3. Economic importance** (food, medicine and industry) **4. Reproduction** (sexual & asexual) **5. Mosses**(e.g. brachymerium and Funaria) and Ferns (i.e. Nephrolepis, Platycerium) a) general characteristics b) reproduction: alternation of generations (sexual and asexual cycle) c) economic importance **6. Photosynthesis** a) Definition b) conditions of photosynthesis c) leaf adaptation of photosynthesis light dependent reactions d) light independent reactions e) products of photosynthesis f) fate of photosynthetic products	the parts. 4. Illustrating the life cycle of rhizopus. 5.Explaining the life cycle of a club fungus 6. Collecting and studying a bracket fungus and identifying the annual rings 7. Stating ways of preventing fungal infections 8. Diagramming reproduction in fungus 9. Drawing and labeling the sexual and asexual reproductive cycles of mosses, ferns 10.growing two plants, one in sunlight and one in the shade to observe the effects of the presence or absence of light on plant growth 11. Wrapping some leaves of a growing plant with aluminum fold and comparing it with other leaves of the same plants after four days.	Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts on algae & fungi • Specimens (yeast, stale bread) club fungi, bracket fungi • Microscope • Plain slide & prepared slide cover slips • Droppers • Beakers • Charts on the life cycles of mosses and ferns • Specimens of growing plants • Aluminum foil • Empty cans • Boiling water • White tile • Iodine solution • Dropper • Green leaf • Ethanol • Variegated leaf • Test tube • Test tube holder • Test tube rack • Clamp and Clamp stand • Bench lamp • Filter funnel • Aquatic plant	reproduction (sexual and asexual) - Explain types of nutrition of fungi - List common fungal diseases • Quizzes on processes of photosynthesis • Students to give short discussion of the light-dependent and light-independent reactions of photosynthesis • Practical assignments on conducting tests for starch, etc.

	g) Macronutrients and micronutrients: their effects in photosynthesis	12. Testing a leaf for starch 13. Testing to break down cell wall and stop the action of enzymes within a leaf 14. Testing to extract chlorophyll 15. Experimenting to demonstrate the need for chlorophyll in photosynthesis 16. Experimenting to demonstrate the need for light in photosynthesis		

SEMESTER: TWO

PERIOD: VI

GRADE: 10

TOPIC : FLOWERING PLANTS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Identify the characteristics of flowering plants and distinguish them from one another
2. Explain what makes flowering plant successful
3. Classify flowering plants into *monocotyledonae* (monocots) and *dicotyledonae* (dicots)
4. State the distinguishing characteristics of monocots and dicots
5. Describe the structures and functions of roots, stems, and leaves; and flowers of flowering plants.

6. Explain sexual and asexual reproduction in flowering plants
7. Draw and label a flower, stating the function of each part
8. Determine and write the floral formulae of flowers such as flamboyant (*Delonix)*, Pride of Barbados (*Caesalpinia*) and Rattle Box (*Crotalaria)*
9. State types of pollination and list agents of pollination
10. Explain the process of zygote and embryo formation in flowering plants
11. Describe the conditions for seed germination
12. Name the types of fruits and explain fruit and seed dispersal
13. List and describe plant hormones and their functions
14. Explain transport system in plants
15. Discuss the process of excretion in plants
16. Describe the process of plant growth and development
17. Explain the process of gaseous exchange in plant

OUTCOMES	CONTENT	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Accept that flowering plants are major food producers in the biosphere and are very important in the food chain. Appreciate the concept of how water, food and minerals are transported in vascular plants. Realize that plants excrete waste materials.	**1. Flowering plants:** a) classification (monocots & Discots) b) Success of flowering plants **2. Functions of roots, stems, leaves and flowers** **3. Floral formulae of flowers:** i.e. Flamboyant (Delonix), pride of Barbados (Caesalpinia) and rattle box (Crotalaria). **3. Types of plants tissues** **4. Root system:** a) types b) regions of root tip, c) functions and structures of root hairs **5. Modified roots, stems and leaves** **6. Leaf classification and arrangement of stem** **7. Germination: types** (epigeal and hypogeal) - conditions	1. Drawing and labeling the parts of a typical flower and stating their functions 2. Illustration of the types of vegetative propagation (cutting, grafting, etc) 3. Setting up an experiment to demonstrate the two types of germination - using corn seed (kernel) and bean seed.. 4. Examine the	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science*	• Short answer questions for students to: - Identify characteristics of flowering plants - Distinguish flowering plants from one another - Classify flowering plants in monocots and dicots • Asking students to use seeds to demonstrate germination in plants • Questions/answers on: - Sexual and asexual reproduction in

	8. Reproduction in flowering plants **9. Kinds of fruits and dispersal of fruits and seeds** – agents **10. Tropisms and plant growth hormones** **11. Primary and secondary growth in plants** **12. Masurement of growth in plants** **13. Nastic and Tactic Movements in plants** **14. Transport system in vascular plants** **15. Excretion in plants** **16. Excretory product of plants:** water, carbon(IV) oxide, oxygen, Alkaloids, tannis, resins, acids, gums **17. Movement of water and minerals through plants** **18. Movement of organic materials from leaves to roots** **19. Pressure flow hypothesis and cytoplasmic streaming of translocation** **20. Transpiration:** advantages and disadvantages **21. Environmental factors affecting transpiration** **22. Physiological factors affecting the rise of water in xylem:** root pressure, transpiration, cohesion-tension mechanism, adhesion, water potential gradient	internal structure of leaf under the microscope 5. Collecting as many fruits and seeds and classifying them into types. 6. Drawing and labeling cross section of monocot and dicot stems and roots. 7. Explaining the two types of pollination and listing agents of pollination 8. Observing the process of transpiration through experiments 9. Collecting and classifying different kinds of leaves 10. Examining sections of stems and roots, showing different stages of primary	(Pearson, 2009) • charts on plant tissues (ground vascular tissues and dermal tissues) • Charts on the cross section of decoct stem and monocot stem • Microscope and slides • Specimens • Whistle plant with roots, stem leaves & flowers • empty plastic jars/cans • Cups • Soil • Dried seed • Variety of fruits	flowering plants - Floral formulae of flowers - Types of pollination - Types of fruits and fruit and seed dispersal - Plant growth and development - Gaseous exchange in plants - Explaining transport system and excretion in plants - Explaining the primary and secondary growth patterns in plants • Quizzes • Tests • Assignments

	23. Gaseous exchange a) concentration gradient b) structure and function of stomata c) structure and function of lenticels **24. Explanation of metabolic equations** a) $C_6H_{12}O_6 + 6O2 \rightarrow 6CO_2 + 6H_2O$ + Heat energy b) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Heat **25. Types of respiration compared** a) facultative aerobic b) facultative anaerobic	and secondary growth.		

SEMESTER: <u>ONE</u>

PERIOD: <u>I</u>

GRADE: <u>11</u>

TOPIC : VIRUSES AND BACTERIA

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. List the characteristics of viruses
2. Describe the four methods used in studying viruses
3. Classify viruses based on nucleic acid (DNA & RNA) and the organisms they attack

4. Explain the life cycle of a virus
5. List some viral diseases, modes of transmission and methods of prevention
6. Describe bacteria of various kinds and observe them under the microscopes
7. Classify bacteria, and draw and label a typical bacterial cell
8. List and describe some common bacterial diseases and symptoms

9. State preventive measures of bacterial diseases
10. Distinguish between *autotrophic* and *heterotropic* nutrition; and *aerobic*, a*naerobic* and f*acultative* respiration
11. Explain the economic importance of bacteria

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION
Recognize that viruses are agents of diseases some of which are the common diseases around us, like polio, mumps, measles and some sexually transmitted infections (HIV/AIDS, Herpes). Realize that some bacteria are useful to humans.	**1. Virus:** a) General characteristics a) definition b) size & shape c) Composition Structure **2. Classification:** a) bacterial viruses b) animal viruses c) plant viruses **3. Structure of bacteriophage** **4. Life cycles** **5. Common viral Diseases:** cold, flu mumps, chicken pox, rabies, polio, HIV/ ADDS **6. Sexually transmitted Infections (STIs):** a) modes of transmission and prevention	1. Listing and discussing viruses that cause diseases. 2. Drawing and labeling bacteriophage. 3. Diagramming the life cycle Of bactriophage. 4. Identifying and listing common viral diseases. 5. Discussing STIs caused by viruses, modes of 6. Transmission and prevention. Discussing the importance of HIV testing and support. 7. Role playing the causes and 8. Prevention of STIs.	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Biological charts of the various types of viruses • Chart of HIV trend in Liberia • Prepared slides of bacteria • Charts for the shape and types of bacteria microscope • Microscope • Prepared slides of bacteria • Charts of shapes and types of bacteria	• Students to classify viruses and bacteria, and list the characteristics of viruses • Paper and pencil tests for students to: - Describe methods in studying viruses - Classify viruses, and explain their life cycles - List some viral diseases - Classify and describe bacteria of various kinds • Written and oral assignments • Written quizzes/ test • Role play

SEMESTER: ONE

PERIOD: II

GRADE: 11

TOPIC: NUTRITION AND FOOD PRESERVATION

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Explain the concept of nutrition
2. Explain why living things need energy
3. Outline and classify the types of nutrients found in food
4. Write the structural formulae of carbohydrates, proteins and lipids
5. State the importance of nutrients found in food
6. Demonstrate the presence of various nutrients found in food
7. Determine the dental formula of a mammal
8. Explain the importance of dental care in humans
9. Explain the concept of a balance diet
10. Explain the concept of malnutrition
11. Name and discuss various methods of preserving and storing food
12. Preserve food using local resources
13. Explain the biological basis for preserving and storing food

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Realize that all organisms require food for the production of energy to support life processes. Accept that there are different types of nutrition. Realize that proper methods of preserving food prevent food poisoning (spoilage)	**1. Nutrition - Definition and types:** a) Autotrophic nutrition b) Heterotrophic nutrition c) Holozoic nutrition d) Saprobiontic (sarprophytic) nutrition e) Parasitic nutrition f) Mutualistic nutrition **2. Food, nutrients** (carbohydrates, lipids, proteins, vitamins, etc.) and energy	1. Testing for: (a) carbohydrate (b) reducing sugar (Benedict's test) (c) non-reducing sugar(e.g. sucrose) (d) starch (the iodine/potassium iodide test) (e) lipid-present (the emulsion test) (f) proteins (biuret test)	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior*	• Student should write short descriptions of their concepts of nutrition, importance of energy, etc. • Short answer questions for students to: - Outline and classify the types of nutrients found in foods

	3. Structure of carbohydrates, lipids and proteins **4. Teeth and dental formulae** **5. Dental care** **6. Balance diet** **7. Malnutrition** **8. Methods of food preservation:** a) ionization radiations (X-Rays, etc) b) drying c) salting d) smoking e) parboiling f) dehydration g)refrigeration h) frying i) use of oil j) incubation k) Importance of food preservation	(g) vitamin C 2. Classifying the nutrients found in different types of food 3. Identifying structure of carbohydrate, proteins and lipids 4. Using preservative methods on samples of food and comparing them with other food stuffs that have not been Preserved.	*Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **<u>C. Other Resources/Supplementary Readings</u>** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Glucose solution • Benedict's solution • Fehling's solution • Test tubes • Test tube rack • Cassava • Potato • Iodine • Potassium • Vitamin C powder • Filter paper • Ethyl alcohol • Egg albumin • Milk • Copper (II) sulphate • Syringe • Droppers • Orange juice • Lemon juice • Grapefruit juice • Diclorophenolindophenol (DCPIP) dye • Ascorbic acid • Pipette • Sodium hydroxide solution • Filter paper	- Determine dental formula of a mammal, and the importance of dental care - Explain the concepts of balance diet and malnutrition - Name and discuss various methods of preserving and storing food using local resources • Written and oral assignments • Written quizzes/tests • Case Study • Practical assignments

			• Distill water • Groundnuts, fish, milk and pawpaw • Mortar and pestle • Specimens of various food stuffs • Salt • Incubator • Fire wood • Locally made dryer • Charcoal • Coal pot • Pot • Palm oil	

SEMESTER: ONE

PERIOD: III

GRADE: 11

TOPIC : SOIL FORMATION (DIFFERENT METHODS) – MAINLY SEDIMENTARY PROCESS, ROCK AND PARTERNS INNATURE, ENERGY AND ECOLOGY – PATTERNS IN NATURE, ENERGY AND MATERIALS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Distinguish between the different types of soil (loamy, sandy and clay soil)
2. State the effects of erosion on soil fertility
3. List the composition of soil
4. Explain the effects of the overuse of the soil
5. Explain the processes of soil conservation, maintenance, and renewal of fertility
6. Explain the advantages and disadvantages of the slash and burn methods in farming
7. Characterize the reproductive isolating mechanisms of species
8. Distinguish the habitat of an organism from its ecological niche
9. Define population and explain the concept of population diversity
10. Describe the concept of ecological succession
11. Describe the various types of inter-specific interactions among organisms
12. Discuss with the aid of a diagram atrophic structures of ecosystem from food chains and food webs pyramids of numbers
13. Define the productivity of an ecosystem and distinguish between gross primary productivity and net primary productivity
14. Discuss energy flow through the trophic system, the water cycle, the carbon dioxide cycle, the nitrogen cycle, the phosphorus cycle and the sulfurcycle
15. Explain some ways of conserving natural resources
16. Explain the concept of *species* as it relates to the environment and characterize the reproductive isolating mechanisms of species
17. Distinguish between the habitat of an organism and its ecological niche
18. Define population growth and explain the concept of population density
19. Calculate population growth rate, doubling time and percent growth rate, death rate and birth rate
20. Distinction between density dependent and density independent factors that affect population size

21. Distinguish between immigration and emigration
22. Discuss exponential growth curve, sigmoid growth curve and the logistic model

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION
Advocate for the proper disposal of non-biodegradable substances (plastics) into the soil for proper yield of food and cash crops Appreciate the concept of ecosystem and the interdependence of organisms within ecosystems. Realize that organisms interact with their nonliving environment:	**1. Soil:** a. formation b. composition of soil c. types of soil d. fertility e. erosion: causes and prevention f. conservation g. maintenance h. renewal of fertility d) Weathering (a) Physical weathering (b) Chemical weathering' **2. Liberia food and cash crops production** **3. Effects of non- biodegradable substances on soil fertility** **4. Isolation mechanisms of species** **5. Inter-specific interactions** (Biological associations) (a) mutualism (b) commensalism (c) predation (d)parasitism (e) competition **6. Trophic levels:** (a) autotrophs (producers) (b) heterotrophs (consumers) (c) Food chains and webs **7. Conservation of nature** (a) soil conservation	1. Explaining soil formation 2. Collecting, observing and classifying soil types 3. Listing and discussing the composition of soil 4. Observing and discussing the effects of erosion on soil fertility 5. Demonstrating the presence of air in the soil 6. Listing food and cash crops in Liberia 7. Digging in the school yard to observe non-biodegradable substances (plastic materials) 8. Discussing the various inter-specific interactions between species 9. Taking field trips to visit ecosystems such as ponds and forest regions 10.Listing and diagramming	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Samples of different types of soil • Empty cups and jars • Plastic materials • Shovel • Charts of inter-specific interactions • Diagrams of trophic levels • Charts of biocycles	• Essay tasks for students to: - Distinguish between different types of soil - State effects of erosion - List composition of soil; and effect sof erosion - Explain processes of soil conservation; and the advantages and disadvantages of slash and burn methods in farming • Students should discuss the effects of biodegradable substances on soil fertility • Written quizzes/ tests for students to: - Characterize the reproductive isolating mechanisms of species - Distinguish the habitat of an organism from its ecological niche

	(b) forest conservation (c) wildlife conservation (d) oil conservation (e) mineral conservation **8. Biocycles in nature** (a) the water cycle (b) the carbon cycle (c) the nitrogen cycle (d) the phosphorus cycle (e) the sulfur cycle **9. Organisms habitat and ecological niche** **10. population:** a) population density b) population growth rate c) doubling time d) percent growth rate e) birth rate, death rate f) immigration, emigration, density–dependent and density independent factors **11. Ecological succession:** (a) primary and secondary successions (b) pioneer and climax communities	food chains and food webs 11. Diagramming and discussing the bicycles – water, carbon, nitrogen, phosphorus and sulfur cycles.		- Define population and explain the concept of population diversity - Describe the concept of ecological succession - Describe the various types of inter-specific interactions among organisms - Explain the various inter-specific relationships among organisms - Explain the differences between autotrophs and hererotrophs - Explain the importance of biocycles • Practical assessments • Group work

SEMESTER: TWO

PERIOD: IV

GRADE: 11

TOPIC : CELL GROWTH AND REPRODUCTION (MITOSIS AND MEIOSIS)

SPECIFIC OBJECTIVES

Upon completion of the topic, students will be able to:

1. Distinguish between asexual and sexual reproduction
2. List and explain the forms of asexual reproduction
3. Describe the phases of the cell cycle
4. List the events of mitosis and diagram the phases
5. Compare mitosis and meiosis and explain the importance of meiosis in sexual reproduction

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Accept that reproduction is a characteristic of living things and it begins with cell division	**1. Cell growth & reproduction:** a) asexual reproduction - propagation - Fission - budding b) Sexual reproduction -cell cycle i. interphase ii. mitosis iii cytokinesis c) Meiosis - sperm and egg formation	1. Drawing and labeling stages of mitosis and meiosis 2. Examining thin slices of onion root tip to study the stages of mitosis under the microscope 3. Comparing mitosis and meiosis 4. Explaining sperm and egg formation 5. Explaining terms such as gametes, diploid, haploid	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior*	• Short essays to discuss the importance of meiosis in sexual reproduction • -Written quizzes, tests for students to: - Distinguish between asexual and sexual reproduction - List and explain the forms of asexual reproduction - Describe the phases of the cell cycle - List the events of mitosis and

			High Integrated Science (Pearson, 2009) ▪ Microscopes ▪ Slides ▪ Onion bulbs ▪ Scalpels ▪ Charts of mitosis and meiosis ▪ Methalene blue (chemical) ▪ Razor blades ▪ Dropper ▪ Beakers	diagram the phases - Compare mitosis and meiosis and explain the importance of meiosis in sexual reproduction • Oral questions and answers • Class discussion • Practical assignments

SEMESTER: TWO

PERIOD: V

GRADE: 11

TOPIC : NUCLEIC ACIDS, PROTEIN SYNTHESIS, HEREDITY, GENETICS, SEXUALITY AND EVOLUTION

Upon completion of this topic, students will be able to:

1. Explain the term nucleic acids and name the types of nucleic acids
2. Describe the double helix model of DNA structure
3. Outline the process of DNA replication
4. Outline the process of RNA transcription
5. Outline the process of protein synthesis
6. Explain the process of protein synthesis and give examples of the proteins synthesized by humans
7. Explain the meanings of heredity, genetics and sexuality
8. Describe how trait are passed from parents to offspring
9. Explain Mendel's contributions to the understanding of the principles of heredity
10. List factors affecting evolution

11. Demonstrate genetic principles on Mendel's experiment with garden peas.
12. Explain the concept of sexuality and apply it in different situations
13. Discuss linkage and sex-linked characters
14. Describe three sources of evidence of evolution
15. Discuss two theories of the mechanisms of evolution

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS RESOURCES	EVALUATION
Acquire the concept that DNA and RNA are the principal transmitters of genetic characteristics. Realize that proteins play a fundamental role in sustaining the processes that support the survival of living things. Accept that traits are inherited from parents, through the DNA and that genetic disorders are inherited. Therefore, it is important to do medical examination when selecting a partner. Develop positive behaviors and values about oneself. Recognize the effects of gene interactions. Accept the concept of genetic variation.	**1. The two types of nucleic acids**: a) DNA b) RNA **2. Structures of nucleotides** **3. Complementary base pairing** **4. Structure of DNA and RNA** **5. DNA replication** **6. RNA transcription** **7. Stages of protein synthesis** **8. Types of RNA** **9. The importance of protein synthesis** **10. Heredity and genetics:** a) principles of genetics b) Mendel's experiment with garden peas; c) Genetic terms: phenotype, genotype, alleles hybrid, homozygous, heterozygous, monohybrid, dihybrid, dominant and recessive genes **11. Heredity Traits:** hemophilia, mental disorder, sickle cell, color blindness, baldness, heavy ear lobes, etc. a) Indolence of environment on heredity b) Development of traits: Intelligence **12. The ABO blood grouping**	1. Using DNA model to demonstrate the process of DNA replication 2. Using charts to explain the process of RNA transcription 3. Using chart to demonstrate the process of protein synthesis 4. Explaining heredity 5. Describing Mendel's contributions to principles of heredity 6. Describing Mendel's experiments and results 7. Solving monohybrid and dihybrid problems using punnett square 8. Stating the importance of the punnett square 9. Discussing some genetic disorders and diseases. 10. Defining reproductive health and rights. 11. Listing reproductive rights	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Integrated Science for SHS – (Pearson) ▪ DNA model ▪ RNA model ▪ Charts of DNA structure and replication ▪ Charts of RNA structure and transcription ▪ Charts of the process of protein synthesis ▪ Garden peas ▪ Biological charts showing genetically	• Students to explain the structure of DNA and the process of DNA replication • Asking questions to explain the process of protein synthesis • Explain how the sex of an organism is determined. • Explain the sources and theories of evolution. • Written quizzes, tests for students to: - Describe how trait are passed from parents to offspring - Explain Mendel's contributions to the understanding of the principles of heredity - List factors affecting evolution - Demonstrate genetic principles on Mendel's experiment with

	and rhesus factor **13. Evolution and natural selection (Darwin)** **14. Sexuality:** a) reproductive health and rights b)sex determination c) infertility d) cycles of sexuality **15. Variation**: a)continuous variation b) discontinuous variations **16. Sources of variation:** a) crossing over b) independent assortment a) random fusion of gametes **17. Causes of variation:** a) genetic factors b) environmental factors **18. Consequence of variation**– natural selection **19. Population genetics** **20. Convergent evolution** **21. Divergent evolution** **22. Evidence of evolution:** a) fossil records b)comparative (Paleontology) embryology c) comparative biochemistry anatomy **14. Theories of evolution** a) Lamark's theory b) Charles Darvin's theory	12. Discussing the causes of infertility in both man and woman 13. Explaining the five cycles of sexuality 14. Outlining similarity. and differences among different species of vertebrates 15. Studying charts of the comparative anatomy of various classes of vertebrates. 16. Studying charts on developmental stages of vertebrates.	disorder individuals ▪ Explain different stages of vertebrates ▪ Charts of evolution ▪ Charts of comparative anatomy of vertebrates ▪ Charts on developmental stages of vertebrates	garden peas. - Explain the concept of sexuality and apply it in different situations - Discuss linkage and sex-linked characters - Describe three sources of evidence of evolution - Discuss two theories of the mechanisms of evolution • Oral questions and answers • Class discussion

SEMESTER: TWO

PERIOD: VI

GRADE: 11

TOPIC : CHORDATA: FISHES, AMPHIBIANS AND REPTILES

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Explain the general characteristics of the phylum Chordata
2. Classify the phylum chordata with its three major phyla
3. Describe the differences between vertebrates and invertebrates
4. List the general characteristics of the fish and explain the differences among the three groups (jawless, cartilaginous and bony)
5. State the economic importance of fishes
6. List the general characteristics of amphibians
7. Describe the external & internal features of the amphibians using a frog
8. Differentiate the structural differences between frog and toad
9. Explain the success of reptiles on land as opposed to amphibians.

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS RESOURCES	EVALUATION

Accept the economic importance of fishes, amphibians and reptiles and their nutritional values	**1. Chordates:** general characteristics: a) primitive chordates - amphioxus b) vertebrate: i. Primitive fish ii. Cartilaginous fish iii. Bony fish c) differences among the three groups d) general characteristics of fish e) Adaptation, locomotion, respiration and economics importance. **2. Amphibians:**	1. Identifying and describing the internal and external structures of a fish 2. Explaining the importance of a fish 3. Collecting and dissecting fish and frog to study the digestive and circulatory systems 4. Collecting and dissecting a lizard	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000)	• Explain the nutritional value of fishes • Written quizzes, tests and exams for students to: - Explain the general characteristics of the phylum Chordata - Classify the phylum chordata with its three major phyla - Describe the differences between vertebrates and invertebrates

	general characteristics a) External & internal features of a frog, b) metamorphosis **3. Reptiles:** a) general characteristics b) external & internal features of lizard c) internal fertilization and the amniotic egg	and studying the external features, digestive, circulatory and respiratory systems 5. Drawing and labeling the amniotes egg and studying the extra-embryonic membranes.	Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Integrated Science for SHS – (Pearson) • Live frog, fish and lizard • Dissecting sets • Dissecting tray • Biological charts of amphioxus, shark, fish, amphibians and reptiles • Gloves • Pins • Scissors • Razor blades • Water	- List the general characteristics of the fish and explain the differences among the three groups (jawless, cartilaginous and bony) - State the economic importance of fishes - List the general characteristics of amphibians - Describe the external & internal features of the amphibians using a frog - Differentiate between the structures of the frog and the toad - Explain the success of reptiles on land as opposed to amphibians. • Oral questions and answers • Class discussion • Practical assignments

SEMESTER: ONE

PERIOD: I

GRADE: 12

TOPIC : CHORDATA: BIRDS AND MAMMALS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. State the general characteristics of birds and mammals
2. Explain the adaptations made by birds for flight
3. Describe the external and internal features of birds
4. Name and classify the different kinds of mammals
5. Describe and state functions of some internal organs of mammals
6. Classify mammals on the basis of the methods of reproduction and the structure of the foot
7. Explain the control mechanisms of body temperature of aquatic, flying and primitive mammals

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS RESOURCES	EVALUATION

Identify and appreciate the shared characteristics of human and other higher chordates.	**1. Birds:** a) general charcteristics b) external and internal features c) types of birds (flight and non-flight) d) adaptation to flight e) types of feathers **2. Mammals:** a) general characteristics -male and female	1. Examining the external features of birds a) studying, drawing and labeling the three types of feathers studying and examining contents of chicken egg 2. Listing the general characteristics of mammals a) stating the structures and functions of	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide	Paper and pencil tests for students to: - State the general characteristics of birds and mammals - Explain the adaptations made by birds for flight - Describe the external and internal features of birds - Name and classify the

	reproductive systems b) orders of mammals c) features of each order d) structure of a typical mammalian molar tooth e)dentition and dental formulae **3. control mechanisms of body temperature of aquatic, flying and primitive mammals**	the male and female reproductive systems 3. Describing features of each order a) Drawing and labeling a typical mammalian molar tooth b) Writing dental formulae of rabbit, dog and man c) Describing of the control mechanisms of the body temperature of aquatic, flying and primitive mammals.	**C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Integrated Science for SHS – (Pearson) • Charts of birds and mammals • Live bird (chicken) • Live animal (rat, cat, dog. • Chicken eggs • Preserved specimen of birds and mammals	different kinds of mammals - Describe and state functions of some internal organs of mammals - Classify mammals on the basis of the methods of reproduction and the structure of the foot - Explain the control mechanisms of body temperature of aquatic, flying and primitive mammals - Describe adaptation made by birds for flight. • Written quizzes, tests and exams • Oral questions and answers • Class discussions • Practical assignments

SEMESTER: ONE

PERIOD: II

GRADE: 12

TOPIC : SKELETAL, MUSCULAR AND REPRODUCTIVE SYSTEMS

SPECIFIC OBJECTIVES

Upon completion of this topic, student will be able to:

1. List the regions of the human skeletal system
2. State the functions of the human skeletal system
3. Name and describe the locations of the various types of joints
4. List and describe the functions of the three types of muscle tissues
5. Describe the effects of sexually transmitted infections (STIs) and substance abuse on the skeletal and muscular systems
6. Describe the body changes during adolescence development
7. Explain the process of gamete formation
8. Explain the functions of the male and female reproductive organs
9. Draw the male and female reproductive organs
10. Describe the structure and function of a sperm cell
11. Explain the menstrual cycle
12. Explain the reproductive health consequences of Gender Based Violence
13. State the benefits of family planning and various methods used

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS RESOURCES	EVALUATION

Outline the importance of bones and muscles in body movement and coordination Take appropriate preventive measures to prevent sexually transmitted infections that destroys the skeletal	**1. Division of the human body** a) (head, neck, trunk and appendages) b) Body cavities **2. Skeletal system:** a) composition: bones, cartilage, ligaments and tendons b) Regions:	1. Discussion of cell and tissue of the skeletal and muscular systems 2. Drawing and labeling the skeletal and muscular systems	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann,	• Written test for students to: - List the regions of the human skeletal system - State the functions of the human skeletal system - Name and describe the locations of the

system Articulate the emotions that accompany adolescence sexual development which will enable them to prevent STIs and teenage pregnancy.	- axial skeleton - appendicular skeleton c) Functions of the skeleton/bones d) Types of joints, functions and locations **3. Muscular system:** a) types and functions of muscle tissues **4. Effects of sexually transmitted infections and substance abuse on the skeletal, muscular and reproductive systems** **5. Adolescence development** **6. Gamete formation:** a) oogenesis b) spermatogenesis **7. Male and female reproductive organs** **8. Sperm and egg** **9. Menstrual cycle** **10. Fertilization and conception** a) sex determination b) infertility **11. Cycles of sexuality** **12. Sexually transmitted infections (STIs):** -modes of transmission and methods of prevention **13. HIV/AIDS:** - immune system, risky behaviors, care and support, stigma and discrimination and importance of testing **14. Gender Based Violence** **15. Family Planning**	3. Examining and studying bone cells under the microscope 4. Listing the bones of the skeletal system 5. Explaining types and functions of the muscle tissues 6. Listing the effects of Sexually Transmitted Infections (STIs) and substances abuse on the human system and their methods of prevention 7. Describing the stages of adolescence 8. Demonstrating oogenesis and spermatogenesis by use of model and diagram 9. Describing the male and female reproductive organs and their functions 10. Drawing and labeling	2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts of the human skeletal, muscular and reproductive systems • Prepared slides of bone cells and cartilage cells • Chart of the human body regions and cavities • Models and charts of oogenesis and spermatogenesis • Charts of the male and female reproductive organs • Chart of the menstrual cycle • Chart showing stages of fetal development from the zygote (fertilized egg) • Chart of family planning methods	various types of joints - List and describe the functions of the three types of muscle tissues - Describe the effects of sexually transmitted infections (STIs) and substance abuse on the skeletal and muscular systems - Describe the body changes during adolescence development - Explain the process of gamete formation - Explain the functions of the male and female reproductive organs - Draw the male and female reproductive organs - Describe the structure and function of a sperm cell - Explain the menstrual cycle - Explain the reproductive health consequences of Gender Based Violence - State the benefits of family planning and

		11. the structure of sperm cell 12. Describing the stages of menstrual cycle 13. Explaining fertilization and development of the fetus 14. Stating causes of infertility 15. Discussing sexually transmitted diseases, with emphasis on HIV/AIDS 16. Explaining and discussing the reproductive health consequences of gender based violence 17. Describing the benefits of family planning		various methods used • Written quizzes, tests and exams • Oral questions and answers • Class discussion • Using charts of the male and female reproductive organs to draw and label organs and sperm cell.

SEMESTER: ONE

PERIOD: III

GRADE: 12

TOPIC : DIGESTIVE, CIRCULATORY AND LYMPHATIC SYSTEMS

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Describe the organs of the digestion system
2. Explain nutrition, and classes of food and their specific uses
3. State the functions of enzyme in the process of digestion
4. Define minerals and vitamins and discuss the importance of vitamins to the body
5. List the components of blood and describe their functions and blood clotting process
6. Examine blood under the microscope to observe the white and red blood cell
7. State the functions of the heart
8. Explain the functions of arteries, veins and capillaries
9. Identify and explain the types of circulation
10. Discuss the lymphatic system, and the functions and composition of lymph
11. Describe the structure and functions of lymph nodes
12. Name and give the function of other lymphoid organs (tonsils, spleen, thymus)

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS RESOURCES	EVALUATION

Outline the nutritional benefits of eating a balanced diet of locally available food. Appreciate the role of the lymphatic system in the defense mechanism of the body. Accept that both the lymphatic and circulatory systems are transport systems.	**1. Digestive system:** a) nutrition – classes of food and their specific uses **2. Alimentary canal:** a) mouth (teeth & tongue b) esophagus c) stomach d) intestines, exocrine glands (salivary and pancreatic glands) e) liver & functions **3. Circulatory system** a) heart	1. Drawing and labeling the alimentary canal 2. Stating the functions of digestive enzymes 3. Describing absorption through the villi and hepatic portal veins 4. Listing and describing classes of	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson,	• Paper and pencil tests to get students to: - Describe the organs of the digestion system - Explain nutrition, and classes of food and their specific uses - State the functions of enzyme in the process of digestion - Define minerals and vitamins and discuss the importance of

	b) blood vessels c) blood cells and plasma b) types of circulations systematic and pulmonary **4. Blood types and Rh Factor** **5. Effects of substance abuse on the circulatory system** **6. Lymphatic system:** a) lymph b) lymphatic vessels c) lymph node d) lymphocytes (T-cells and B-cells)	food and their importance 5. Discussing the effects of malnutrition on growth and development, and on the immune system 6. Describing the steps or processes of nutrition: digestion -absorption -assimilation 7. Testing for carbohydrates, proteins and oils 8. Stating the functions of the liver in digestion 9. Discussing the effects of alcohol & drugs on the organs of these systems 10. Describing the composition of the blood and its functions 11. Explaining the process of blood clothing	2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Integrated Science for SHS – (Pearson) • Charts of: a) Circulatory system; d) Heart e) Blood vessels f) Digestive system g) Mouth, teeth, tongue h) Esophagus i) Stomach j) Intestine • Microscope • Slides • Prepared slides • Peeling needle • Model and charts of the lymphatic system	vitamins to the body - List the components of blood and describe their functions and blood clotting process - State the functions of the heart - Explain the functions of arteries, veins and capillaries - Identify and explain the types of circulation - Discuss the lymphatic system, and the functions and composition of lymph - Describe the structure and functions of lymph nodes - Name and give the function of other lymphoid organs (tonsils, spleen, thymus) • Students should examine blood under the microscope to observe the white and red blood cell, and record their observation • Case studies • Written quizzes, tests and exams • Oral questions and

		12. Listing the various blood groups and the Rh factor 13. Drawing and labeling the heart and liver 14. Studying charts of the lymphatic system 15. Drawing and labeling the lymphatic system		answers • Class discussion

SEMESTER: TWO

PERIOD: IV

GRADE: 12

TOPIC : EXCRETORY, RESPIRATORY SYSTEMS AND GASEOUS EXCHANGE: THE PROCESS OF CELLULAR RESPIRATION(GLYCOLYSIS, PYRUVATE AND KREB CYCLE)

SPECIFIC OBJECTIVES

Upon completion of this topic, students will be able to:

1. Explain the process of excretion
2. List and describe the functions of the kidney, ureter and urinary bladder
3. Describe the excretory function of other organs such as skin, liver, lungs, and large intestine
4. Explain the homeostatic role of the excretory system
5. State the characteristics of the two types of respiration
6. List the tissues and organs in the mechanic of breathing.
7. Explain the effects of substance abuse and STIs on the two systems (excretory and respiratory)
8. Discuss cellular respiration citing the major sequential stages making a metabolic pathway of numerous reactions (Glycolysis, link reaction, Krebscycle and electron transport chain)
9. Distinguish between aerobic and anaerobic respiration
10. Discuss anaerobic respiration in the muscle and yeast/fruits (alcoholic respiration)
11. Discuss the significance of phosphorylation in glycolysis
12. Identify the final products of glycolysis
13. Discuss the fate of pyruvate
14. Discuss oxidation and reduction with regards to oxygen, hydrogen and electrons
15. Distinguish between decarboxylation reactions and dehydrogenation reactions
16. Identify the four main events during glycolysis
17. Explain the summary equation for respiration ($C_6H_{12}O_6 + 6O_2$ ---→ $6OCO_2 + 6H_2O$)
18. Identify the three types of electron carriers located in the inner membrane of the mitochondria (flavoproteins, quinones and cytochromes)
19. Summarize the events in the Krebs cycle

OUTCOMES	CONTENT	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Take appropriate steps to prevent damage to the excretory and respiratory organs. Realize that the energy released in gaseous	**1. Excretory system:** organs a) kidneys b) urinary bladder c)Urethra d)Skin, Liver, Lungs **2. Respiratory system:**	1. Explaining the process of excretion 2. Describing the functions of tissues and organs in both external & internal	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts**	• Written quizzes, tests and exams for students to: - Explain the process of excretion - List and describe the functions of the

exchange (respiration) is key to the survival of all living organisms. Realize that there are two principal types of respiration.	organs **3. Kinds of respiration** a) internal & external b) phases (inspiration and expiration) **4.Artificial resuscitation** **5. Effects of substance abuse and STIs on the organs of the two systems** **6. Definition of cellular respiration** (aerobic and anaerobic) **7. The formation of ATP**, a phosphorylated nucleotide **8. An overview of respiration:** a) glycolysis b) link reaction c) Krebs cycle d) electron transport chain **9. Coenzymes and respiration** **10. Nicotinamide adnine dinucleotide (NAD) and dehydrogenase enzymes** **11. Events of glycolysis** **12. Pyruvate and its fate** **13. Alcoholic fermentation** (anaerobic and aerobic respiration in yeast and fruits) **14. Anaerobic respiration** in muscles and Oxygent debt **15. Recations of the Krebs cycle** (tricarboxylic acid – TCA cycle/cirtic acid cycle): a) decarboxylation	respiration 3. Describing the lungs and the air passage ways 4. Drawing and labeling the longitudinal section of the kidney 5. Discussing the role of the diaphragm, intercostal muscles and ribs in respiration 6. Stating the effects and naming of organs affected by substance abuse and STIs 7. Vigorous exercise 8. Obtaining palm wine and placing it in a plastic gallon to observe alcoholic fermentation	• Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts of kidneys, ungs and kin • Palm wine • Grape fruits • Plastic gallons • Knife • Strainer • Large container (pan)	kidney, ureter and urinary bladder - Describe the excretory function of other organs such as skin, liver, lungs, and large intestine - Explain the homeostatic role of the excretory system - State the characteristics of the two types of respiration - List the tissues and organs in the mechanic of breathing. - Explain the effects of substance abuse and STIs on the two systems (excretory and respiratory) - Discuss cellular respiration citing the major sequential stages making a metabolic pathway of numerous reactions (Glycolysis, link reaction, Krebs cycle and electron transport chain) - Distinguish between aerobic and anaerobic respiration - Discuss anaerobic respiration in the

	b) dehydrogenation c) oxidative phosphorylation **16. Electron transport chain** (Etc) and ATP synthesis: a) flavoproteins b) quinones c) cytochromes			muscle and yeast/fruits (alcoholic respiration) - Discuss the significance of phosphorylation in glycolysis - Identify the final products of glycolysis - Discuss the fate of pyruvate - Discuss oxidation and reduction with regards to oxygen, hydrogen and electrons - Distinguish between decarboxylation reactions and dehydrogenation reactions - Identify the four main events during glycolysis - Explain the summary equation for respiration ($C_6H_{12}O_6 + 6O_2$ --- → $6OCO_2 + 6H_2O$) - Identify the three types of electron carriers located in the inner membrane of the mitochondria (flavoproteins, quinones and cytochromes)

				- Summarize the events in the Krebs cycle • Oral questions and answers • Class discussion • Drama or role play • Quizzes • Practical and written assignments • Short answer tests

SEMESTER: TWO

PERIOD: V

GRADE: 12

TOPIC : NERVOUS AND ENDOCRINE SYSTEMS (CONTROL AND CO-ORDINATION OF BODY ACTIVITIES)

SPECIFIC OBJECTIVES

Upon the completion of this topic, students will be able to:

1. Compare and contrast the operations of the nervous and endocrine systems
2. Describe the structure and functions of the brain and a neuron
3. Give the classification of neurons
4. Draw the nervous system and list the major parts
5. Describe the structure and functions of the spinal cord
6. Name the various regions of the spinal cord
7. Name and give the functions of the central and peripheral nervous systems
8. Differentiate between voluntary and involuntary actions
9. Discuss the causes and effects of substance abuse on the nervous system
10. Describe the structures and functions of the eye and ear
11. Explain the effects of some STIs on the nervous system
12. State the functions of exocrine glands, endocrine gland and hormones
13. Explain the regulation of hormone secretion through negative feedback
14. Describe the two basic mechanisms of hormones action

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION

Outline the perfect coordination features in the control of body activities by both nervous and chemical control in the body. .	**1. The nervous system** a) Composition: - central nervous system -Peripheral nervous system **2. reflex action** **3. The nervous system** Spinal cord: (a) structure and function	1. Listing and describing parts of the nervous system 2. Examining and explaining models of the brain and spinal cord 3. Identifying various parts of the brain and spinal cord	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008).	Written quizzes, tests and exams for students to: - Compare and contrast the operations of the nervous and endocrine systems - Describe the structure and functions of the brain and a neuron

	(b) sensory and motor Neurons (c) structure and types Of neurons (d) structure of the brain **4. Generation and transmission of nerve impulses:** (a) resting potential (b) action potential (c) refractory period (d) conduction of nerve impulses (e) role of the myelin Sheath (f) synapses and synaptic transmission (g) structure and function of synapse **5. Voluntary and involuntary actions** **6. Reflexes and reflex arc** **7. Autonomic nervous system: functions and importance** **8. Structure & function of eye and ear** **9. Effects of STIs in the organs of the nervous system** **10. Substance abuse: causes effects and prevention**	4. Drawing and labeling the parts of the brain and spinal cord 5. Describing the peripheral nervous system 6. Describing the structures and functions of the eye and ear 7. Explaining reflex reaction 8. Listing organs of the nervous system that STIs and substance abuse affect 9. Explaining the causes and corrections of vision defects 10. Drawing, labeling and discussing, the skin as a sense organ 11. Drawing and labeling a typical motor neuron 12. Examining the model and chart of mammalian eye 13. Drawing and labeling the whole eyeball to show its external and internal structures	• Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts of nervous system, endocrine system, eye & ear • Dissecting set • Dissecting tray • Microscope • Prepared slides • Model of brain, spinal cord, eye and ear	- Give the classification of neurons - Draw the nervous system and list the major parts - Describe the structure and functions of the spinal cord - Name the various regions of the spinal cord - Name and give the functions of the central and peripheral nervous systems - Differentiate between voluntary and involuntary actions - Discuss the causes and effects of substance abuse on the nervous system - Describe the structures and functions of the eye and ear - Explain the effects of some STIs on the nervous system - State the functions of exocrine glands, endocrine gland and hormones - Explain the regulation of

	11. Endocrine system a) glands b) The role of the testes and ovaries as endocrine glands b) Hormone deficiency diseases	14. Examining model and charts of the mammalian ear and identifying the parts 15. Drawing and labeling the ear to show its external and internal parts		hormone secretion through negative feedback - Describe the two basic mechanisms of hormones action • Oral questions and answers • Class discussion and home assignment

SEMESTER: TWO

PERIOD VI

GRADE: 12

TOPIC : HUMAN ECOLOGY, HEALTH, NATURAL RESOURCES AND POLLUTION

SPECIFIC OBJECTIVES

Upon the completion of this topic, students will be able to:

1. Explain the concept of natural resources
2. Distinguish between renewable and non-renewable natural resources
3. Discuss the importance of natural resources
4. Explain methods of conserving natural resources
5. Explain ecosystem approach to natural resource management
6. Define and explain the term *pollution*
7. State the causes and effects of pollution
8. Discuss ways and means of controlling pollution
9. Explain the importance of vaccination and inoculation as a means of preventing human diseases
10. Explain the importance of personal as well as community health

11. State the dangers posed by drugs, alcoholic drinks and smoking
12. Define and explain the term *sewage disposal*
13. Discuss different methods of sewage disposal
14. Identify economic uses of sewage

15. Discuss sources of water, modes of contamination and methods of purification
16. Discuss methods of refuse collection and disposal
17. State the importance of first aid and be able to treat a numbers of conditions

OUTCOMES	CONTENTS	ACTIVITIES	MATERIALS/ RESOURCES	EVALUATION
Appreciate the importance of conservation of natural resources. Accept the concept that natural resources contribute towards the wealth of a nation Accept the concept that pollution is harmful to human, plant and animal lives. Realize that renewable natural resources need to be regenerated and must be stained/used wisely. Realize the non-renewable natural resources need to be used wisely Realize that the usefulness of flow renewable resources. Realize that water is an indispensable value to man's survival and therefore should be conserved.	**1 .Definition of natural resources** **2. Renewable and non-renewable natural resources** **3. Definition and examples of flow renewable resources** **4.Conservation of natural resources** **5. Definition of pollution** **6. Causes of pollution:** a) air pollution b) fresh water c) soil d) sea e) thermal f) noise **7. Control of pollution** **8. vaccination and immunization** **9. Personal hygiene** **10. Drug abuse**	1. Group discussion on the importance of conservation or natural resources 2. Making field trips and viewing sites of natural resources such as rain forests, gold mines, diamond mines, rivers, lakes, ocean/beach, coal mine, iron ore, rubber factory, petroleum refinery, etc. 3. Taking field trips to observe: a) solar radiation, b) tides c) Winds, etc. 4. Field trips to water purification plant 5. Field trips to sewage treatment plant 6. Discussing different methods of sewage disposal	**A. Primary Text** Baffour Asante-Owusu, et al. *Senior High Biology* (Longman, 2009) **B. Secondary Texts** • Sue Hocking, et al. *OCR Biology* (OCR/Heinemann, 2008). • Doris Koto, et al., *Senior Secondary Guide – Biology* (Pearson, 2000) Senior Secondary Guide **C. Other Resources/Supplementary Readings** • Bob McDuell, *Senior High Integrated Science* (Pearson, 2009) • Charts of various kinds of natural resources • Samples of natural resources • Beaker • Contaminated water • Microscope • Slides • Cover slips	• written quizzes, tests, assignments and exams to get students to: - Explain the concept of natural resources - Distinguish between renewable and non-renewable natural resources - Discuss the importance of natural resources - Explain methods of conserving natural resources - Explain ecosystem approach to natural resource management - Define and explain the term *pollution* - State the causes and effects of pollution - Discuss ways and means of controlling pollution - Explain the importance of vaccination and inoculation as a means of preventing human diseases - Explain the

Realize that immunization prevents people against diseases. Accept the concept that drug abuse is harmful to the well-being of people.	**11. Community hygiene** **12. Sewage disposal:** a) definitions of sewage and sewage disposal k) methods of sewage disposal l) economic uses of sewage **13. Water:** a) Sources b) mode of contamination/pollution c) methods of purification **14. Refuse collection and disposal**	7. Discussing uses of sewage 8. Purifying water by boiling, chlorination and sand filtration (pumping water through sand filter to remove particles greater then 0.002mmdiameter). 9. Testing water for contaminants 10. Filtering contaminated water using clean cloth 11. Practicing first aid exercises on partners 12. Observing nitrogen-fixing bacteria under microscope 13. Estimating the alcohol content of various drinks	• Roots of legume plants • Filter paper • Pipette • Methylene blue • Thermometer • Flask • Stopper • Alcohol • Gauze mat • Tripod • Buncen burner • Gas light • Clean cloth • Funnel • Porcelain filter • Soil • Rocks • Coal and coal pot • Petroleum product (kerosene, fuel oil) • Sand • Wood • Chlorine • Charts on water purification system • Charts on sewage disposal • Fertilizers	importance of personal as well as community health - State the dangers posed by drugs, alcoholic drinks and smoking - Define and explain the term *sewage disposal* - Discuss different methods of sewage disposal - Identify economic uses of sewage - Discuss sources of water, modes of contamination and methods of purification - Discuss methods of refuse collection and disposal - State the importance of first aid and be able to treat a numbers of conditions • oral questions and answers • brainstorming and class discussion

The printing of the National Liberian Curriculum is provided by ECSEL

- European Commission Support for Education in Liberia

thesis2

ORIGINALITY REPORT

11%	9%	6%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	open.metu.edu.tr Internet Source	1%
2	apps.who.int Internet Source	1%
3	Submitted to Yakın Doğu Üniversitesi Student Paper	1%
4	Selina Neri. "Chapter 547 Shareholder and Stakeholder Activism", Springer Science and Business Media LLC, 2023 Publication	<1%
5	docs.neu.edu.tr Internet Source	<1%
6	fastercapital.com Internet Source	<1%