NEAR EAST UNIVERSITY
FACULTY OF ENGINEERING
BIOMEDICAL ENGINEERING

NOYAN BATUHAN ARIKAN

ŞÜKRÜ YARIMLIER

ENGİN İLHAN

Blood Vessel Locator (the VESLOC)

Supervisor: Dr.Zafer Topukçu

[Graduation Project]

2013-Lefkoşa

DESIGN OF A VESSEL LOCATOR DEVICE
(VESLOC)

GRADUATION PROJECT SUBMITTED TO THE ENGINEERING FACULTY

OF

NEAR EAST UNIVERSITY

by

NOYAN BATUHAN ARIKAN

SUKRU YARIMLIER

ENGIN ILHAN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE DEGREE OF BACHELOR OF SCIENCE

IN

BIOMEDICAL ENGINEERING

Supervisor: Op Dr Zafer Topukçu

LEFKOŞA – 2013

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to our supervisor Dr.Zafer Topukçu for his valuable suggestions, patience, positive guidance and his great role in the development of this project and help given to us throughout the duration of our project.

We would like to express our warm thanks to Dr.Zafer Topukçu for his valuable support during our education.

This graduation project was technically supported to the most by AVCAN Elektronik private company with the owner Hüseyin AVCAN. We are grateful for all the supports.

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INTRODUCTION

Blood is a specialized bodily fluid in human being that delivers necessary substances such as nutrients and oxygen to the cells and transports metabolic waste products away from those same cells.

Due to a particular medical problem at some era in the life of every human being has to give blood. However, this procedure is not always so easy. Successful venous access often belongs to experience, skills and proper techniques. At the same time, it is a critical application that requires the right equipment, purpose, drug infusion or right cannula detection depending on the physical characteristics of the patient. Opening vascular access in childrens, obese patients and patients under going with chemotherapy are very difficult application.There is sometimes a necessary to openvascular access from the crotch and this is a very challenging application for even doctors.

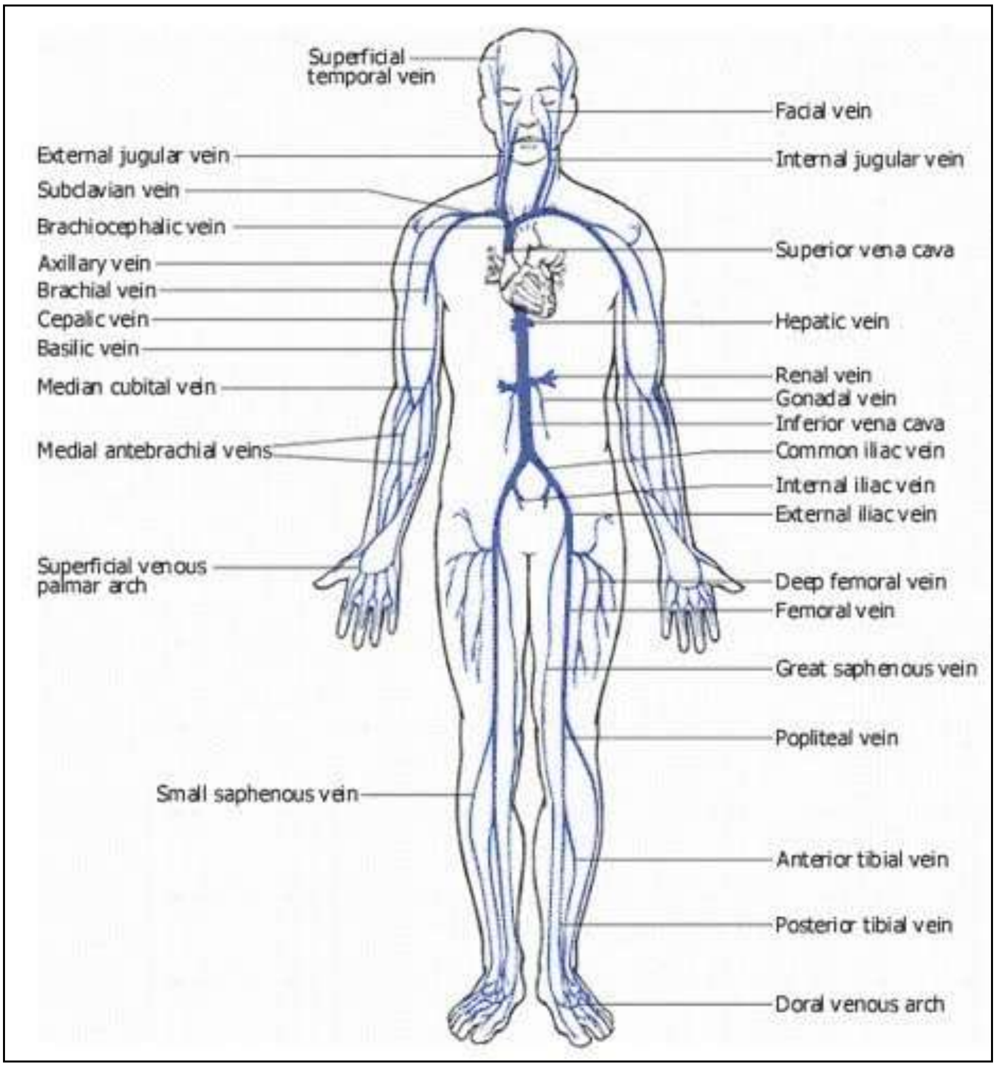
In obese patients, the existence of substantial deposits of subcutaneous fat makes it difficult to locate veins either by touch or vision. Also, the adipose tissue often tends to take the appearance of a vein leading to unsuccessful draws in the area.

Locating veins in children is particularly challenging, because most of them do not cooperate and are apprehensive about vein sticks. Anxiety causes the patient’s blood pressure to rise thereby narrowing the veins. This vein narrowing is a greater issue for concern in children due to the small sized veins they already have.

In cases of medical emergencies such as hemorrhage, acute renal failure, hypotension, shock and cardiac arrest, immediate access to the patient’s vein has to be achieved. However, very often, even skilled paramedics or physicians may be unsuccessful in obtaining access in patients.

The aim of the device that we designed is eliminate the problems while procedure of vascular access. The “*vesloc®*” imaging system permits viewing contrast-enhanced images of the venous system in real-time. Thus, the person who opens vascular access is able to complete the process with great ease instead of vascular access to vein experimentally and exposing the patient needle strikes.

HUMAN ANATOMY



Anotomy of Veins

THE VEINS convey the blood from the capillaries of the different parts of the body to the heart. They consist of two distinct sets of vessels, the pulmonary and systemic.

The Pulmonary Veins, unlike other veins, contain arterial blood, which they return from the lungs to the left atrium of the heart.

The Systemic Veins return the venous blood from the body generally to the right atrium of the heart.

The Portal Vein, an appendage to the systemic venous system, is confined to the abdominal cavity, and returns the venous blood from the spleen and the viscera of digestion to the liver. This vessel ramifies in the substance of the liver and there breaks up into a minute network of capillary-like vessels, from which the blood is conveyed by the hepatic veins to the inferior vena cava.

The veins commence by minute plexuses which receive the blood from the capillaries. The branches arising from these plexuses unite together into trunks, and these, in their passage toward the heart, constantly increase in size as they receive tributaries, or join other veins. The veins are larger and altogether more numerous than the arteries; hence, the entire capacity of the venous system is much greater than that of the arterial; the capacity of the pulmonary veins, however, only slightly exceeds that of the pulmonary arteries. The veins are cylindrical like the arteries; their walls, however, are thin and they collapse when the vessels are empty, and the uniformity of their surfaces is interrupted at intervals by slight constrictions, which indicate the existence of valves in their interior. They communicate very freely with one another, especially in certain regions of the body; and these communications exist between the larger trunks as well as between the smaller branches. Thus, between the venous sinuses of the cranium, and between the veins of the neck, where obstruction would be attended with imminent danger to the cerebral venous system, large and frequent anastomoses are found. The same free communication exists between the veins throughout the whole extent of the vertebral canal, and between the veins composing the various venous plexuses in the abdomen and pelvis, e. g., the spermatic, uterine, vesical, and pudendal.

The systemic venous channels are subdivided into three sets, superficial and deep veins, and venous sinuses.

The Deep Veins accompany the arteries, and are usually enclosed in the same sheaths with those vessels. With the smaller arteries as the radial, unlar, brachial, tibial, peroneal they exist generally in pairs, one lying on each side of the vessel, and are called venæ comitantes. The larger arteries such as the axillary, subclavian, popliteal, and femoral have usually only one accompanying vein. In certain organs of the body, however, the deep veins do not accompany the arteries; for instance, the veins in the skull and vertebral canal, the hepatic veins in the liver, and the larger veins returning blood from the bones.

Venous Sinuses are found only in the interior of the skull, and consist of canals formed by a separation of the two layers of the dura mater; their outer coat consists of fibrous tissue, their inner of an endothelial layer continuous with the lining membrane of the veins.

The Veins of the Upper Extremity

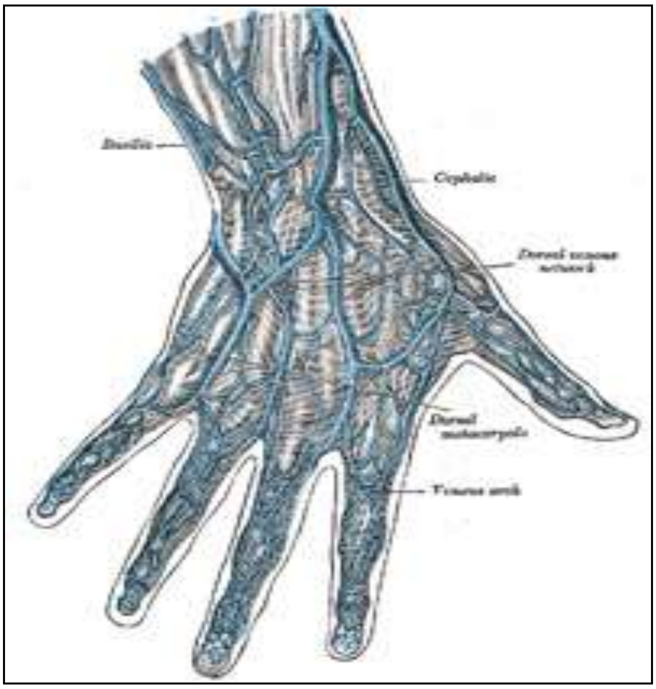
The veins of the upper extremity are divided into two sets, superficial and deep; the two sets anastomose frequently with each other. The superficial veins are placed immediately beneath the integument between the two layers of superficial fascia. The deep veins accompany the arteries, and constitute the venæ comitantes of those vessels. Both sets are provided with valves, which are more numerous in the deep than in the superficial veins.

The Superficial Veins of the Upper Extremity

The superficial veins of the upper extremity are the digital, metacarpal, cephalic, basilic, median.

Digital Veins pass along the sides of the fingers and are joined to one another by oblique communicating branches. Those from the adjacent sides of the fingers unite to form three dorsal metacarpal veins, which end in a dorsal venous net-work opposite the middle of the metacarpus. The radial part of the net-work is joined by the dorsal digital vein from the radial side of the index finger and by the dorsal digital veins of the thumb, and is prolonged upward as the cephalic vein. The ulnar part of the net-work receives the dorsal digital vein of the ulnar side of the little finger and is continued upward as the basilic vein. A communicating branch frequently connects the dorsal venous network with the cephalic vein about the middle of the forearm.

The volar digital veins on each finger are connected to the dorsal digital veins by oblique intercapitular veins. They drain into a venous plexus which is situated over the thenar and hypothenar eminences and across the front of the wrist.

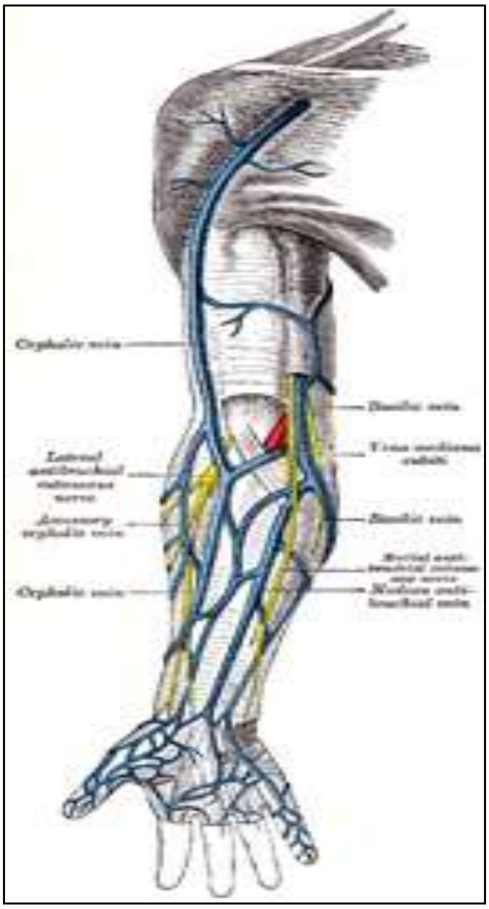


The veins on the dorsum of the hand. (Bourgery.)

The cephalic vein*begins* in the radial part of the dorsal venous net-work and winds upward around the radial border of the forearm, receiving tributaries from both surfaces. Below the front of the elbow it gives off the vena mediana cubiti (*median basilic vein*), which receives a communicating branch from the deep veins of the forearm and passes across to join the basilic vein. The cephalic vein then ascends in front of the elbow in the groove between the Brachioradialis and the Biceps brachii. It crosses superficial to the musculocutaneous nerve and ascends in the groove along the lateral border of the Biceps brachii. In the upper third of the arm it passes between the Pectoralis major and Deltoideus, where it is accompanied by the deltoid branch of the thoracoacromial artery. It pierces the coracoclavicular fascia and, crossing the axillary artery, ends in the axillary vein just below the clavicle. Sometimes it communicates with the external jugular vein by a branch which ascends in front of the clavicle.

The accessory cephalic vein (*v. cephalica accessoria*) *arises* either from a small tributory plexus on the back of the forearm or from the ulnar side of the dorsal venous net-work; it joins the cephalic below the elbow. In some cases the accessory cephalic springs from the cephalic above the wrist and joins it again higher up. A large oblique branch frequently connects the basilic and cephalic veins on the back of the forearm.

The basilic vein (*v. basilica*) *begins* in the ulnar part of the dorsal venous network. It runs up the posterior surface of the ulnar side of the forearm and inclines forward to the anterior surface below the elbow, where it is joined by the vena mediana cubiti. It ascends obliquely in the groove between the Biceps brachii and Pronator teres and crosses the brachial artery, from which it is separated by the lacertus fibrosus; filaments of the medial antibrachial cutaneous nerve pass both in front of and behind this portion of the vein. It then runs upward along the medial border of the Biceps brachii, perforates the deep fascia a little below the middle of the arm, and, ascending on the medial side of the brachial artery to the lower border of the Teres major, is continued onward as the axillary vein.



The superficial veins of the upper extremity.

The median antibrachial vein (*v. mediana antibrachii*) drains the venous plexus on the volar surface of the hand. It ascends on the ulnar side of the front of the forearm and ends in the basilic vein or in the vena mediana cubiti; in a small proportion of cases it divides into two branches, one of which joins the basilic, the other the cephalic, below the elbow.

The Veins of the Lower Extremity, Abdomen, and Pelvis

The Veins of the Abdomen and Pelvis

The veins of the lower extremity are subdivided, like those of the upper, into two sets, superficial and deep; the superficial veins are placed beneath the integument between the two layers of superficial fascia; the deep veins accompany the arteries. Both sets of veins are provided with valves, which are more numerous in the deep than in the superficial set. Valves are also more numerous in the veins of the lower than in those of the upper limb.

The Superficial Veins of the Lower Extremity

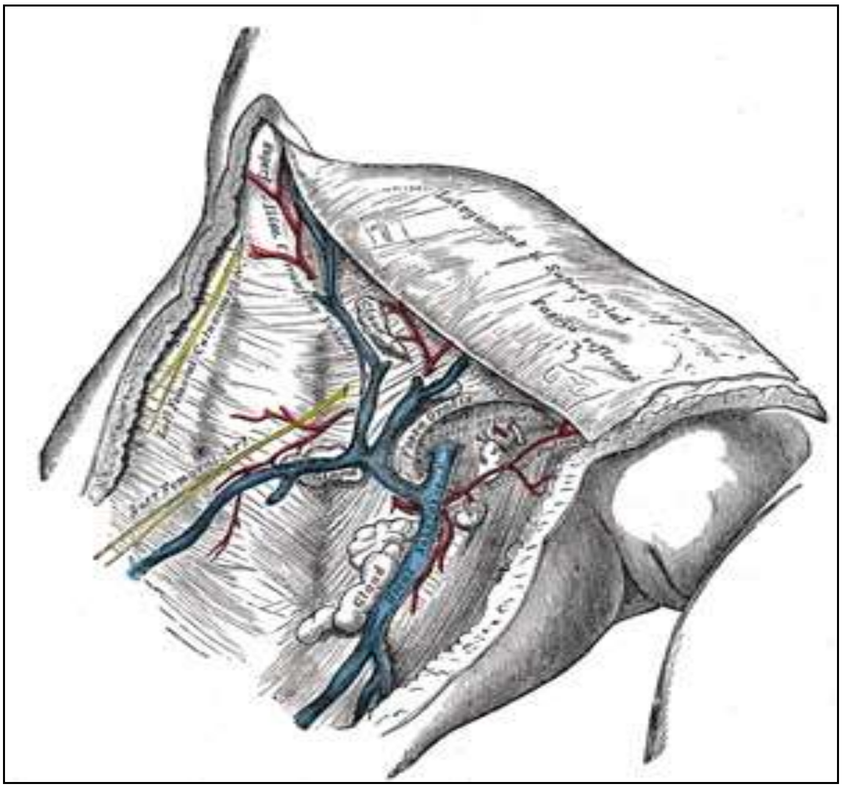
The superficial veins of the lower extremity are the great and small saphenous veins and their tributaries.

On the dorsum of the foot the dorsal digital veins receive, in the clefts between the toes, the intercapitular veins from the plantar cutaneous venous arch and join to form short common digital veins which unite across the distal ends of the metatarsal bones in a dorsal venous arch. Proximal to this arch is an irregular venous net-work which receives tributaries from the deep veins and is joined at the sides of the foot by a medial and a lateral marginal vein, formed mainly by the union of branches from the superficial parts of the sole of the foot.

On the sole of the foot the superficial veins form a plantar cutaneous venous arch which extends across the roots of the toes and opens at the sides of the foot into the medial and lateral marginal veins. Proximal to this arch is a plantar cutaneous venous net-work which is especially dense in the fat beneath the heel; this net-work communicates with the cutaneous venous arch and with the deep veins, but is chiefly drained into the medial and lateral marginal veins.

The great saphenous vein (*v. saphena magna; internal or long saphenous vein*) , the longest vein in the body, *begins* in the medial marginal vein of the dorsum of the foot and ends in the femoral vein about 3 cm. below the inguinal ligament. It ascends in front of the tibial malleolus and along the medial side of the leg in relation with the saphenous nerve. It runs upward behind the medial condyles of the tibia and femur and along the medial side of the thigh and, passing through the fossa ovalis, ends in the femoral vein.

Tributaries; at the ankle it receives branches from the sole of the foot through the medial marginal vein; in the leg it anastomoses freely with the small saphenous vein, communicates with the anterior and posterior tibial veins and receives many cutaneous veins; in the thigh it communicates with the femoral vein and receives numerous tributaries; those from the medial and posterior parts of the thigh frequently unite to form a large accessory saphenous vein which joins the main vein at a variable level. Near the fossa ovalis it is joined by the superficial epigastric, superficial iliac circumflex, and superficial external pudendal veins. A vein, named the thoracoepigastric, runs along the lateral aspect of the trunk between the superficial epigastric vein below and the lateral thoracic vein above and establishes an important communication between the femoral and axillary veins.



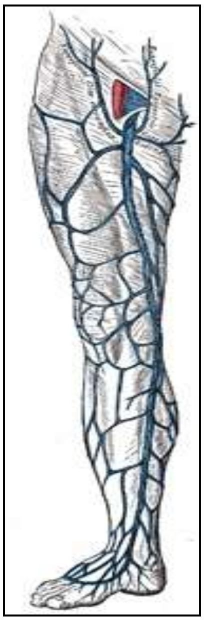
The great saphenous vein and its tributaries at the fossa ovalis.

The valves in the great saphenous vein vary from ten to twenty in number; they are more numerous in the leg than in the thigh.

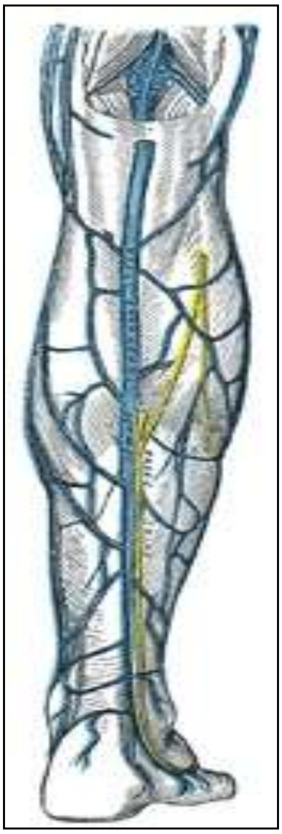
The small saphenous vein (*v. saphena parva; external or short saphenous vein*) *begins* behind the lateral malleolus as a continuation of the lateral marginal vein; it first ascends along the lateral margin of the tendocalcaneus, and then crosses it to reach the middle of the back of the leg. Running directly upward, it perforates the deep fascia in the lower part of the popliteal fossa, and ends in the popliteal vein, between the heads of the Gastrocnemius. It communicates with the deep veins on the dorsum of the foot, and receives numerous large tributaries from the back of the leg. Before it pierces the deep fascia, it gives off a branch which runs upward and forward to join the great saphenous vein. The small saphenous vein possesses from nine to twelve valves, one of which is always found near its termination in the popliteal vein. In the lower third of the leg the small saphenous vein is in close relation with the sural nerve, in the upper two-thirds with the medial sural cutaneous nerve.

The Deep Veins of the Lower Extremity

The deep veins of the lower extremity accompany the arteries and their branches; they possess numerous valves.



The great saphenous vein and its tributaries. (See enlarged image)



The small saphenous vein.

The plantar digital veins (*vv. digitales plantares*) *arise* from plexuses on the plantar surfaces of the digits, and, after sending intercapitular veins to join the dorsal digital veins, unite to form four metatarsal veins; these run backward in the metatarsal spaces, communicate, by means of perforating veins, with the veins on the dorsum of the foot, and unite to form the deep plantar venous arch which lies alongside the plantar arterial arch. From the deep plantar venous arch the medial and lateral plantar veins run backward close to the corresponding arteries and, after communicating with the great and small saphenous veins, unite behind the medial malleolus to form the posterior tibial veins.

The posterior tibial veins (*vv. tibiales posteriores*) accompany the posterior tibial artery, and are joined by the peroneal veins.

The anterior tibial veins (*vv. tibiales anteriores*) are the upward continuation of the venæ comitantes of the dorsalis pedis artery. They leave the front of the leg by passing between the tibia and fibula, over the interosseous membrane, and unite with the posterior tibial, to form the popliteal vein.

The Popliteal Vein (*v. poplitea*) is formed by the junction of the anterior and posterior tibial veins at the lower border of the Popliteus; it ascends through the popliteal fossa to the aperture in the Adductor magnus, where it becomes the femoral vein. In the lower part of its course it is placed medial to the artery; between the heads of the Gastrocnemius it is superficial to that vessel; but above the knee-joint, it is close to its lateral side. It receives tributaries corresponding to the branches of the popliteal artery, and it also receives the small saphenous vein. The valves in the popliteal vein are usually four in number.

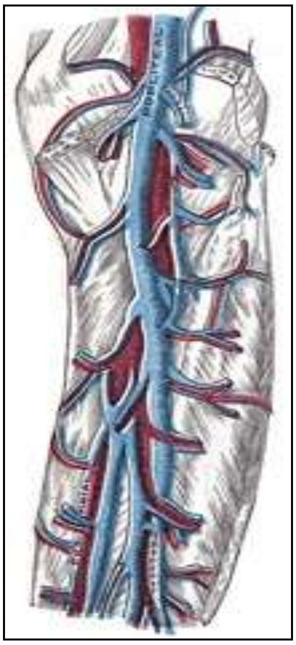


FIG. 8– The popliteal vein.

The femoral vein (*v. femoralis*) accompanies the femoral artery through the upper two-thirds of the thigh. In the lower part of its course it lies lateral to the artery; higher up, it is behind it; and at the inguinal ligament, it lies on its medial side, and on the same plane. It receives numerous muscular tributaries, and about 4 cm. below the inguinal ligament is joined by the v. profunda femoris; near its termination it is joined by the great saphenous vein. The valves in the femoral vein are three in number.

The Deep Femoral Vein (*v. profunda femoris*) receives tributaries corresponding to the perforating branches of the profunda artery, and through these establishes communications with the popliteal vein below and the inferior gluteal vein above. It also receives the medial and lateral femoral circumflex veins.

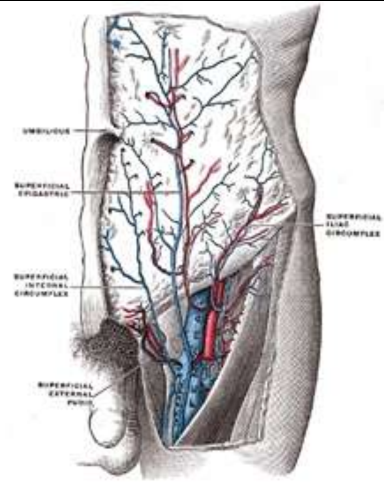
The external iliac vein (*v. iliaca externa*), the upward continuation of the femoral vein, begins behind the inguinal ligament, and, passing upward along the brim of the lesser pelvis, ends opposite the sacroiliac articulation, by uniting with the hypogastric vein to form the common iliac vein. On the right side, it lies at first medial to the artery: but, as it passes upward, gradually inclines behind it. On the left side, it lies altogether on the medial side of the artery. It frequently contains one, sometimes two, valves.

Tributaries; the external iliac vein receives the inferior epigastric, deep iliac circumflex, and pubic veins.

The Inferior Epigastric Vein (*v. epigastrica inferior; deep epigastric vein*) is formed by the union of the venæ comitantes of the inferior epigastric artery, which communicate above with the superior epigastric vein; it joins the external iliac about 1.25 cm. above the inguinal ligament.

The Deep Iliac Circumflex Vein (*v. circumflexa ilium profunda*) is formed by the union of the venæ comitantes of the deep iliac circumflex artery, and joins the external iliac vein about 2 cm. above the inguinal ligament.

The Pubic Vein communicates with the obturator vein in the obturator foramen, and ascends on the back of the pubis to the external iliac vein.

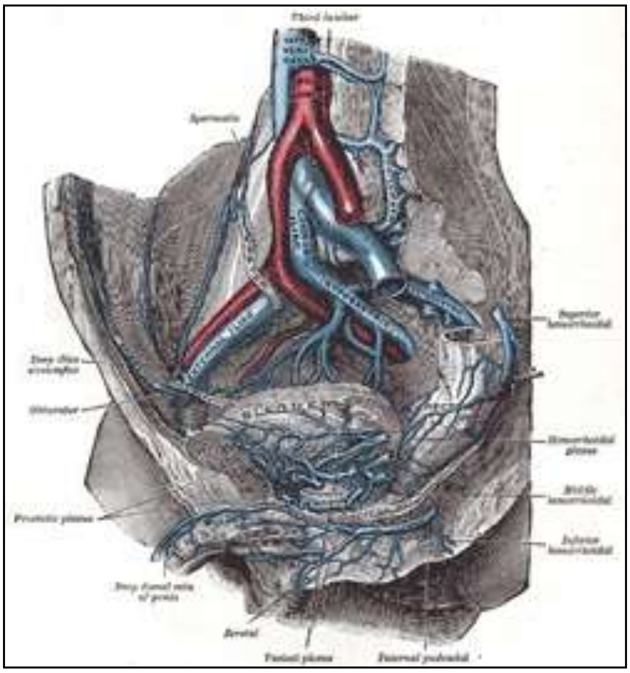


The femoral vein and its tributaries. (Poirier and Charpy.)

The hypogastric vein (*v. hypogastrica; internal iliac vein*) *begins* near the upper part of the greater sciatic foramen, passes upward behind and slightly medial to the hypogastric artery and, at the brim of the pelvis, joins with the external iliac to form the common iliac vein.

Tributaries; with the exception of the fetal umbilical vein which passes upward and backward from the umbilicus to the liver, and the iliolumbar vein which usually joins the common iliac vein, the tributaries of the hypogastric vein correspond with the branches of the hypogastric artery. It receives (*a*) the gluteal, internal pudendal, and obturator veins, which have their origins outside the pelvis; (*b*) the lateral sacral veins, which lie in front of the sacrum; and (*c*) the middle hemorrhoidal, vesical, uterine, and vaginal veins, which originate in venous plexuses connected with the pelvic viscera.

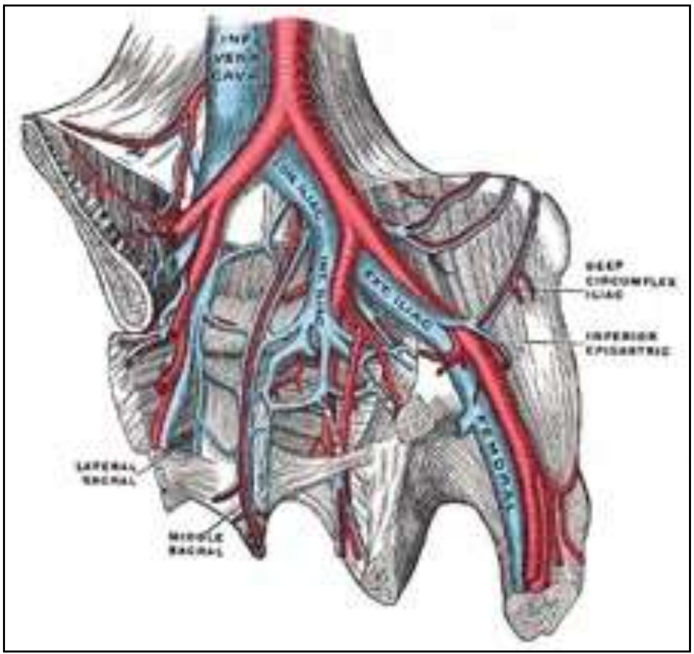
1.The Superior Gluteal Veins (*vv. glutaeæ superiores; gluteal veins*) are venæ comitantes of the superior gluteal artery; they receive tributaries from the buttock corresponding with the branches of the artery, and enter the pelvis through the greater sciatic foramen, above the Piriformis, and frequently unite before ending in the hypogastric vein.



The veins of the right half of the male pelvis. (Spalteholz).

2.The Inferior Gluteal Veins (*vv. glutaeæ inferiores; sciatic veins*), or venæ comitantes of the inferior gluteal artery, *begin* on the upper part of the back of the thigh, where they anastomose with the medial femoral circumflex and first perforating veins. They enter the pelvis through the lower part of the greater sciatic foramen and join to form a single stem which opens into the lower part of the hypogastric vein.

3.The Internal Pudendal Veins (*internal pudic veins*) are the venæ comitantes of the internal pudendal artery. They *begin* in the deep veins of the penis which issue from the corpus cavernosum penis, accompany the internal pudendal artery, and unite to form a single vessel, which ends in the hypogastric vein. They receive the veins from the urethral bulb, and the perineal and inferior hemorrhoidal veins. The deep dorsal vein of the penis communicates with the internal pudendal veins, but ends mainly in the pudendal plexus.



The iliac veins. (Poirier and Charpy.)

4.The Obturator Vein (*v. obturatoria*) *begins* in the upper portion of the adductor region of the thigh and enters the pelvis through the upper part of the obturator foramen. It runs backward and upward on the lateral wall of the pelvis below the obturator artery, and then passes between the ureter and the hypogastric artery, to end in the hypogastric vein.

5.The Lateral Sacral Veins (*vv. sacrales laterales*) accompany the lateral sacral arteries on the anterior surface of the sacrum and end in the hypogastric vein.

6. The Middle Hemorrhoidal Vein (*v. hæmorrhoidalis media*) takes origin in the hemorrhoidal plexus and receives tributaries from the bladder, prostate, and seminal vesicle; it runs lateralward on the pelvic surface of the Levator ani to end in the hypogastric vein.

The hemorrhoidal plexus (*plexus hæmorrhoidalis*) surrounds the rectum, and communicates in front with the vesical plexus in the male, and the uterovaginal plexus in the female. It consists of two parts, an internal in the submucosa, and an external outside the muscular coat. The internal plexus presents a series of dilated pouches which are arranged in a circle around the tube, immediately above the anal orifice, and are connected by transverse branches.

The lower part of the external plexus is drained by the inferior hemorrhoidal veins into the internal pudendal vein; the middle part by the middle hemorrhoidal vein which joins the hypogastric vein; and the upper part by the superior hemorrhoidal vein which forms the commencement of the inferior mesenteric vein, a tributary of the portal vein. A free communication between the portal and systemic venous systems is established through the hemorrhoidal plexus.

Depth of Veins

This ultrasonographic study performed in 55 infants and children is an interesting reminder that puncture of a vessel or nerve under echographic guidance is more than simply identifying a target and trying to guide the needle tip to it: it also implies initial careful identification of all structures present around the target.

The authors positioned the patients in the usual way for right internal jugular vein puncture: supine, with a small rolled towel under the shoulders and with the head rotated 15-30° to the left. An ultrasound probe was placed perpendicular to the skin, halfway between the mastoid process and the sternal notch. They identified the carotid artery, internal jugular vein and vertebral artery.

The following parameters were measured and recorded: distance between skin and vertebral artery (>20.1mm, 15.1 to 20mm, <15mm), width of the vertebral artery (<2mm, 2.1 to 4mm, >4.1mm), distance between the jugular vein and the vertebral artery (>6.1mm, 4.1 to 6mm, 2.1 to 4mm, <2mm) and the extent of overlap between the jugular vein and the vertebral artery (none, partial or total).

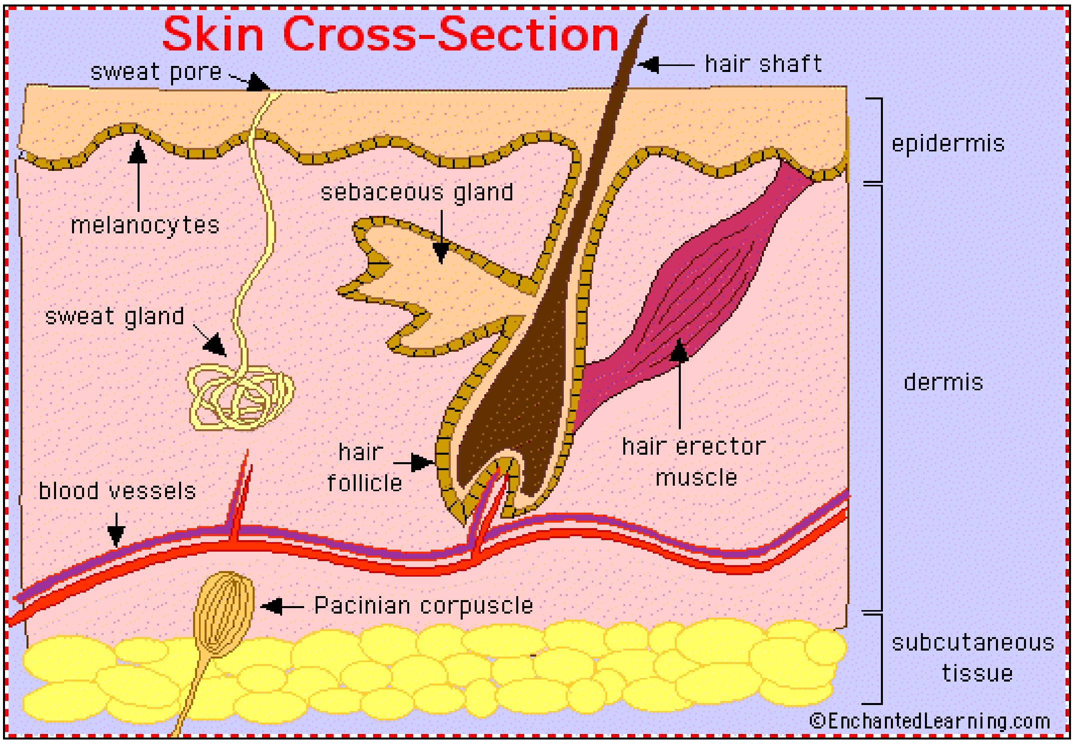
Using these parameters and a 0 to 3 scoring system, they identified three groups of risk (high, moderate and low) for accidental puncture of the vertebral artery during attempts to puncture the internal jugular vein. The main results are that the mean distance between the skin and vertebral artery was 15.3mm (3.3mm), 7/55 patients were at high risk for accidental puncture of the vertebral artery and the patients in the high-risk group were younger and smaller (but no statistically significant difference was found).

It is thus important to identify the vertebral artery before attempting to puncture the internal jugular vein under echographic guidance: if it is close to the vein, or if overlap of both structures is present, the needle tip should be directed away from the artery. Moreover, these findings question the safety of deliberately transfixing the vein with the needle tip.

Skin Anatomy

The largest organ of the body is the skin, which is multilayered with its three main layers being epidermis, dermis and the subcutaneous layer, also called the hypodermis.

The epidermis is the outermost layer and does not contain any blood vessels. It allows light to pass through it owing to its presence in the superficial section of skin. The middle layer known as the dermis contains capillaries, glands and hair follicles. Diffusion takes place between the dermis and epidermis to provide nutrient supply. The hypodermis lying above the muscle and bone is the lowermost layer in the skin consisting of fat cells, veins, arteries and nerves. The amount of subcutaneous fat in this layer determines the penetration of light into tissue beneath it. Children possess skin of lesser thickness as compared to adults. The depth of epidermis ranges from 0.027 to 0.15mm and that of dermis ranges from 0.6 to 3mm. The hypodermal thickness can be between 0 to 3mm with the maximum in the abdomen.



<u>The epidermis</u>, the top most layer of skin, is only 0.1 to 1.5 millimeters thick. It is made up of five layers: the basal cell layer, the squamous cell layer, the stratum granulosum, the stratum lucidum, and the stratum corneum. Working together, these layers continually rebuild the surface of the skin from within, maintaining the skin's strength and helping thwart wear and tear.The process begins in the basal cell layer, the innermost layer of the epidermis. This layer houses small round cells called basal cells. These cells constantly divide, with the new cells constantly pushing older ones on a migration toward the surface of the skin.

The basal cell layer is also called the stratum germinativum because it is constantly producing, or germinating, new cells.The basal cell layer also contains melanocytes, specialized cells that produce a pigment called melanin. Melanin protects the skin against sun damage, and its rate of production determines skin color—the more melanin produced in the skin, the darker the skin appears. Exposure to the sun causes the melanocytes to increase melanin production in an effort to shield the skin from damaging ultraviolet rays; the resulting effect is a suntan.

Freckles, birthmarks, and age spots are also caused by patches of melanin within the skin. Above the basal cell layer is the squamous cell layer, also called the stratum spinosum or “spiny layer” because the cells are held together with spiny projections. Here lie the basal cells that have been pushed upward; these maturing cells are now called squamous cells, or keratinocytes. They have begun to produce keratin, a tough, protective protein that makes up a large part of the structure of the skin, hair, and nails. (Horses’ hooves, fish scales, and animal horns are also made of keratin.)The squamous cell layer is the thickest layer of the epidermis. This is the layer of the skin that helps to move certain substances in and out of the body; it’s also where blisters form when the skin is chafed. The squamous cell layer also contains cells called Langerhans cells, If the skin becomes damaged, these cells latch onto invading antigens, substances that are foreign to the body, and alert the immune system to their presence.The keratinocytes from the squamous layer are then pushed up through two thin epidermal layers called the stratum granulosum and the stratum lucidum. As the cells migrate, they enlarge, flatten, and bond together, then eventually become dehydrated and die.

The process fuses the cells into layers of tough. durable material, which continue to rise toward the skin’s surface.As the layers near the surface, they become part of the stratum corneum, the outermost, visible layer of the epidermis. The stratum corneum (or “horny layer,” because its cells are toughened like an animal’s horn) is made up of 10 to 30 thin layers of these dead cells. External pressure or friction can cause thickened areas in the stratum corneum known as corns or calluses.As the outermost cells give way to wear and tear, they are replaced from within by new layers of strong, long-wearing cells. In the average adult, it takes nearly a month for the stratum corneum to be completely replaced. The replacement process generally slows with age, though in some people it becomes abnormally accelerated, causing a flaky, scaly skin condition known as psoriasis.

The dermis, which lies (ust beneath the epidermis, is I .5 to 4 millimeters thick-the thickest of the three layers of the skin. It's also home to most of the skin's structures, including sweat and oil glands (which secrete substances through openings in the skin called pores, or comedos), hair follicles, nerve endings, and blood and lymph vessels. But the main components of the dermis are collagen and elastin.Collagen is a tough, insoluble protein found throughout the body in the connective tissues that hold muscles and organs in place. In the skin, collagen supports the epidermis, lending it its durability. Elastin, a similar protein, keeps the skin flexible. This is the substance that allows the skin to spring back into place when stretched: the scientific reason a funny face won't stay that way, no matter what your mother told you.

The properties of collagen and elastin fade with age, giving rise to wrinkles and sagging skin.In addition to collagen and elastin, you'll find water in the dermis. In fact, much of the body's water supply is stored there. When the amount of stored water is increased—for example, when you're retaining water—the skin becomes tight and stretched as it expands to accommodate the surplus. The dermis also contains scavenger cells from the immune system. In the event that a foreign organism makes it past the epidermis, these cells will engulf and destroy it.Several structures can be found in the dermis. Sweat glands, numbering about 3 million in the average person, are the most numerous and are classified according to two types: the apocrine glands and the eccrine glands.Apocrine glands are specialized sweat glands that can be found only in the armpits and pubic region. In animals, it is the apocrine glands that secrete the scents used to attract a mate; however, no one is sure of their function in humans. What we do know is that these glands secrete a milky sweat that encourages the growth of bacteria responsible for body odor. These glands are activated at puberty when stimulated by hormones.The eccrine glands are the true sweat glands. Found over the entire body, these glands regulate body temperature by bringing water via the pores to the surface of the skin, where it evaporates and releases heat. These glands respond to heat, exercise, and fever, and some eccrine glands, such as those on the palms, respond to emotional stress, as well. It's these glands that give you clammy hands when you're nervous. Unlike apocrine glands, eccrine glands function from childhood, though they do increase their activity at puberty. Though these glands can produce up to two liters of sweat an hour when they're working at their full potential, they're not usually to blame for body odor. These glands secrete mostly water, which doesn't encourage the growth of odor-producing bacteria.

The dermis is also home to the sebaceous, or oil, glands, which are attached to hair follicles, cylindrical structures that house the roots of the hair. Sebaceous glands can be found everywhere on the body except for the palms of the hands and the soles of the feet. Usually called into action by hormones during puberty, these glands secrete oil that helps keep the skin smooth and supple. The oil also helps keep skin waterproof and protects against an overgrowth of bacteria and fungi on the skin. At times, these glands overproduce and cause acne, a condition in which pores become clogged and inflamed.Nerve endings can also be found in the dermis. Of course, these structures are responsible for the sense of touch, relaying information to the brain for interpretation. They also signal temperature to the brain and, if necessary, trigger shivering, an involuntary contraction and relaxation of muscles. This muscle activity generates body heat.Finally, blood and lymph vessels are found in the dermis.

The blood vessels bring nutrients and oxygen to the skin and remove cell waste and cell products. The blood vessels also carry the vitamin D produced in the skin back to the rest of the body. Enlarged vessels that can be seen through the skin are known as spider veins or varicose veins. Broken blood vessels appear as bruises.The lymph vessels bathe the tissues of the skin with lymph, a milky substance that contains infection-fighting immune system cells.The cells work to destroy any infection or invading organisms as the lymph gradually circulates back through the body’s tissues to the lymph nodes.

The subcutaneous tissue (hypodermis) is the deepest layer of the skin. It is missing on parts of the body where the skin is especially thin-the eyelids, nipples, genitals, and shins. Subcutaneous tissue acts both as an insulator, conserving body heat, and as a shock absorber, protecting internal organs from injury. It also stores fat as an energy reserve in the event extra calories are needed to power the body. The blood vessels, nerves, lymph vessels, and hair follicles also cross through this layer.

BLOOD

The Structure and Functions of Blood

Note: Knowledge of the structure and function of blood and aspects of the heart and vascular system are training in various therapies, (incl. e.g. Massage, Aromatherapy, Acupuncture, Shiatsu, etc.). This page is i to include detail suitable for introductory courses, and some ITEC Diplomas.

This page is divided into the following sections:

1. **The Functions of Blood**
   (generally - as opposed to the functions of particular components of blood).
2. **The Composition of Blood**
   (incl. the different types of blood cells and their properties and functions).
3. **Process of Oxygenation of Tissues due to Circulation of Blood**
4. **Types of Leucocytes** (White Blood Cells)

1. Functions of Blood

1. **Transports:**
   - Dissolved gases (e.g. oxygen, carbon dioxide);
   - Waste products of metabolism (e.g. water, urea);
   - Hormones;
   - Enzymes;
   - Nutrients (such as glucose, amino acids, micro-nutrients (vitamins & minerals), fatty acids, glyce
   - Plasma proteins (associated with defence, such as blood-clotting and anti-bodies);
   - Blood cells (incl. white blood cells 'leucocytes', and red blood cells 'erythrocytes').

2. **Maintains Body Temperature**

3. **Controls pH**

The pH of blood must remain in the range 6.8 to 7.4, otherwise it begins to damage cells.

4. **Removes toxins from the body**

The kidneys filter all of the blood in the body (approx. 8 pints), 36 times every 24 hours. Toxins remo
from the blood by the kidneys leave the body in the urine.

(Toxins also leave the body in the form of sweat.)

5. **Regulation of Body Fluid Electrolytes**

Excess salt is removed from the body in urine, which may contain around 10g salt per day (such as in the cases of people on western diets containing more salt than the body requires).

2. Composition of Blood

Blood consists of many components (constituents).

These include:

55% Plasma

45% Components (sometimes called "formed elements"), i.e. 'Blood Cells'. Of these,

99% are erythrocytes (red blood cells)

and 1% are leucocytes (white blood cells) and thrombocytes (blood platelets)

3. The Oxygenation of Blood

The oxygenation of blood is the function of the erythrocytes (red blood cells) and takes place in the lungs.

The sequence of events of the blood becoming oxygenated (in the lungs) then oxygenating the tissues (in the
is as follows:

4Types of Leucocytes (White Blood Cells)

*Neutrophil

*Eosinophil

*Basophil

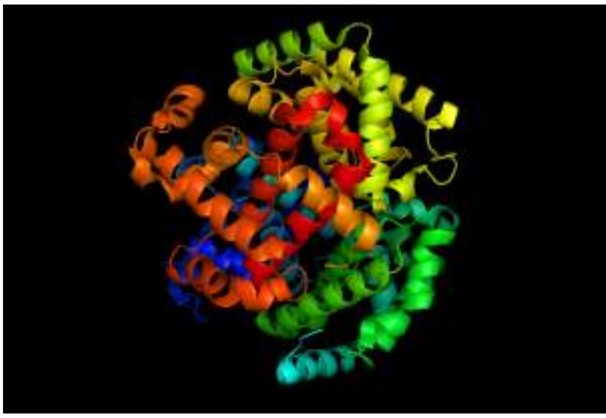
*Lymphocyte

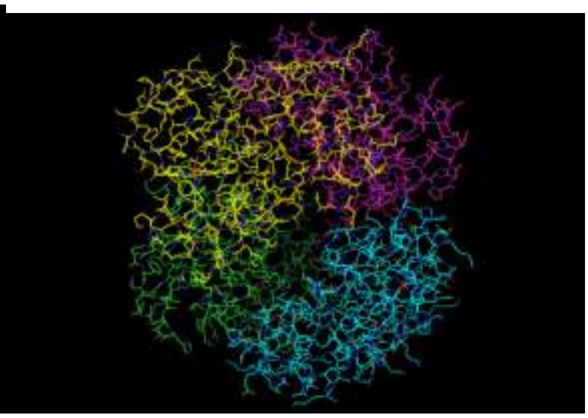
*Monocyte

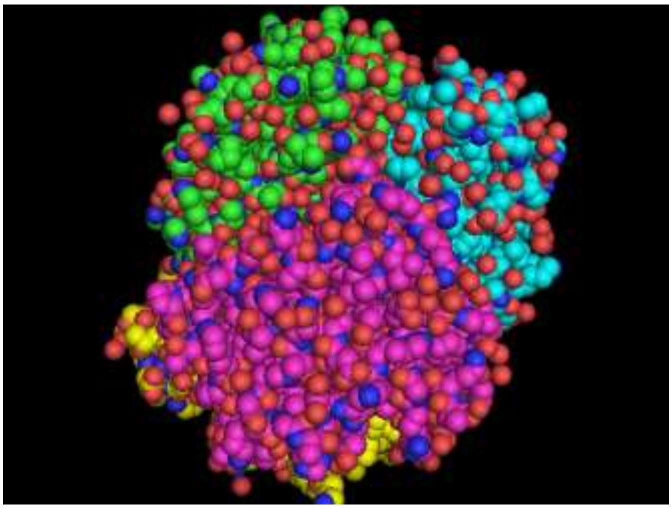
<u>Hemoglobin</u>

Hemoglobin is a protein in red blood cells that transports oxygen from the lungs to the peripheral tissues of th
it is responsible for the red color of red blood cells. Hemoglobin tightly binds oxygen from the lungs, carries
the lungs to the peripheral tissues of the body; after unloading oxygen at the peripheral tissues, it binds
dioxides and returns it to the lungs to be exhaled. It is composed of two protein subunits: alpha ar
Hemoglobin requires both subunits in order to function properly. Disorders can result from abnormalties i
subunits. Abnormal hemoglobin structure or function can result in a variety disorders including sickel c
thalassemia.

Hemoglobins proteins are translated from mRNA which is transcriped from genes. The alpha subunit is enc
four genes while the beta subunit is encoded by two genes. Once made, the subunits become attached to eac
Everybody has the same genes that encode for hemoglobin, therefore, hemoglobin composition is the sa
everyone in the world. Sometimes, although rare, mutations occur in the genes of certain individuals. I
hemoglobin genes, which are passed down from parents to offspring, result in abnormal hemoglobin protei
children of parents with mutated hemoglobin will produce the same abnormal hemoglobin the donor parent h
structure of proteins is very important in determining the function of the protein; therefore, abnormal hem
proteins may lose some of its functions. Although a majority of mutations is harmless, some can result in sic
anemia and thalassemia.







Hemoglobin sturctures made using PyMol and PDB file 101N

Typical Hemoglobin Values(2):

Hemoglobin levels are measured by the amount of hemoglobin in grams (gm) per deciliter (dl) of blood. The ranges for hemoglobin values are dependent on the age and sex. Normal ranges are:

* Newborns: 17-22 gm/dl
* One (1) week of age: 15-20 gm/dl
* One (1) month of age: 11-15gm/dl
* Children: 11-13 gm/dl
* Adult women: 12-16 gm/dl
* Adult males: 14-18 gm/dl
* Women after middle age: 11.7-13.8 gm/dl
* Men after middle age: 12.4-14.9 gm/dl

Significance of low hemoglobin level

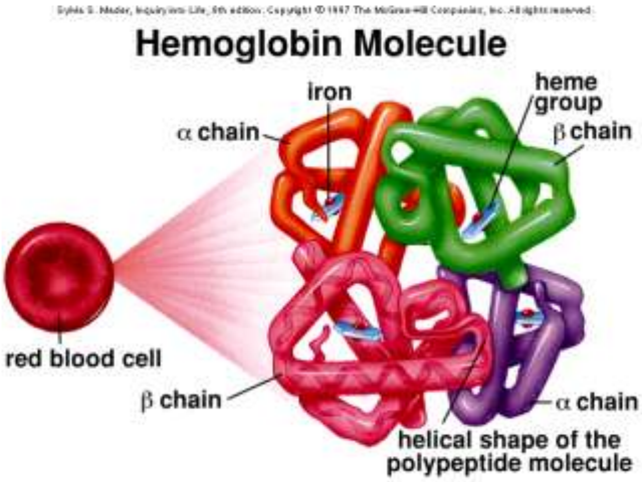
People with low hemoglobin levels are anemic. Anemia can be caused by several factors such as vitamin de (deficiency in iron, vitamin B12 or folate), blood loss, problems with bone marrow or abnormal hemoglobi causes sickle cell anemia.

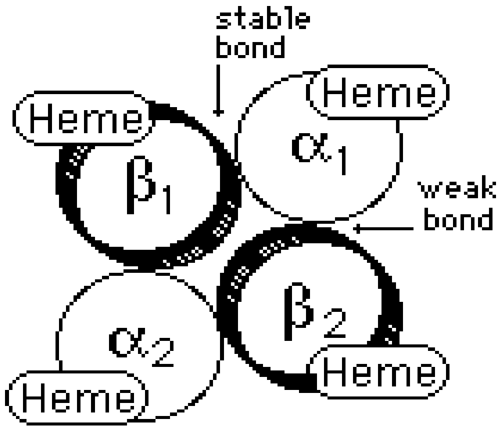
Significance of high hemoglobin levels

People that live in areas of high altitude tend to have high hemoglobin levels. Also, certain illnesses, such as c drug abuse and tumors can cause high hemoglobin levels. Smokers also tend to have high hemoglobin levels.

Hemoglobin Structure

Hemoglobin contains four polypeptide subunits: two alpha chains and two beta chains, each with 141 and 14 acids respectively. The "globin" in hemoglobin refers to the individual protein subunits. Each subunit is co of mainly alpha helices with no beta strands. Each subunit folds into eight alpha helical segments which pocket that holds the heme.





Hemoglobin structure displaying heme group with iron attached

Hemoglobin structure displaying bonds between prot

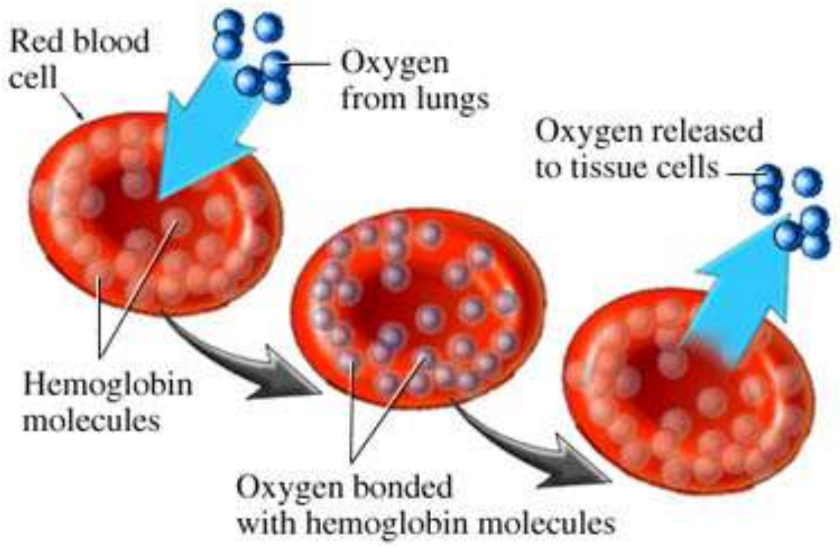
Bohr Effect

Hemoglobin's ability to release oxygen is influenced by its environment, pH and CO2 levels. Genera oxygen-poor environment of the peripheral tissues has a lower pH than the oxygen-rich environment of th The acidic environment of the peripheral tissues results from the reaction between water and CO2, whic bicarbonate and a proton.

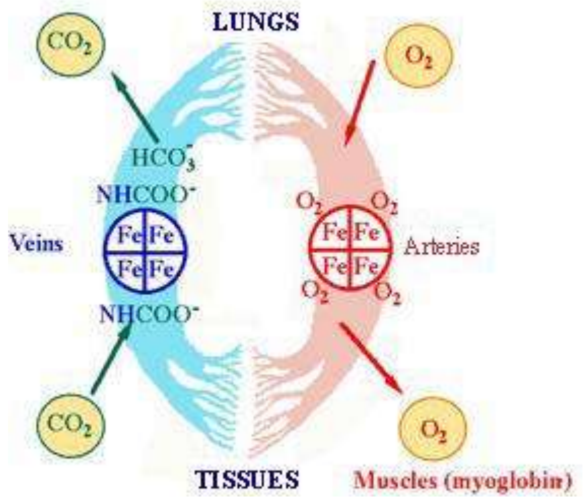
CO2 + H20 -----------------> HCO3- + H+

The acidic nature of the tissues enables the hemoglobin to function properly. Hemoglogin binds to two as four oxygen molecules are released. Protons aid in transferring oxygen from hemoglobin to tis lessening the attraction of hemoglobin for oxygen. This is called the Bohr effect and it is important in mal

right side of the equation more favorable. The Bohr effect is important in removing CO2 from blood. H
more soluble in blood than CO2, therefore, it can bind to hemoglobin and be transported back to the lungs.



Oxygen transport by hemoglobin within red blood cells



Oxygen tranport by hemoglobin displaying iron and oxygen bonds

The dermis is heavily permeated with blood vessels which contain hemoglobin, Hb. Hemoglobin is a containedin the red blood cells (95% of the dry mass of red cells is Hb). Hemoglobin binds very easily to C making it the ideal"vehicle" for the transportation of oxygen from the lungs to the tissue. Hb has a unique abs spectrum with characteristic absorption bands at 420nm and in the 545nm to 575nm range, right where pattern is observed. Using the measurements of Zijlstra et al we plotted the hemoglobin absorption spectrum our skin reflectance measurements.

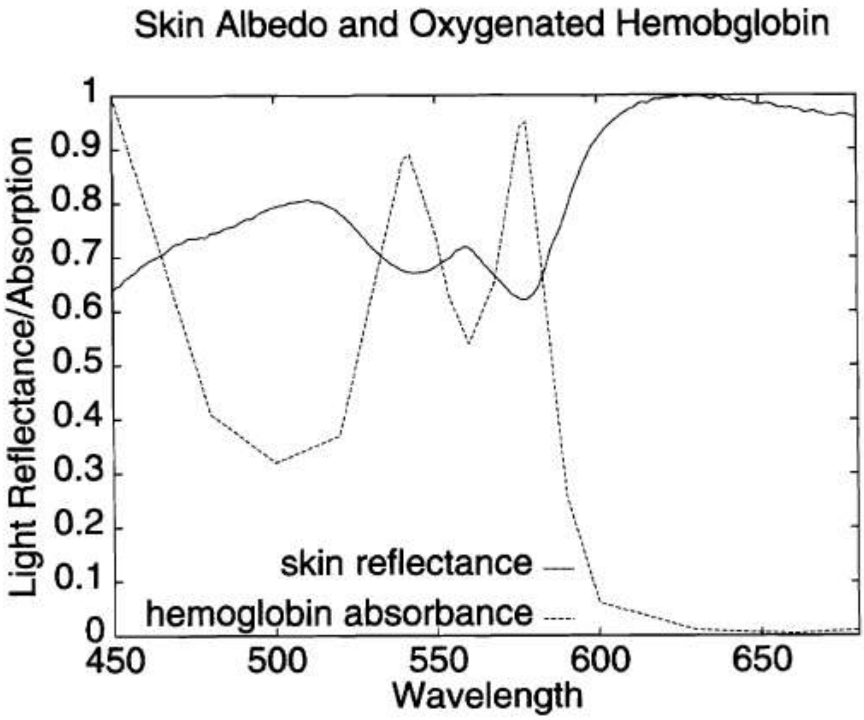


Fig. 16. Skin reflectance vs. hemoglobin absorption.

Hemoglobin Absorption

Absorption spectra of oxygenated (HbO2) and de-oxygenated (Hb) forms of hemoglobin are some what dif hence the difference in color between arterial and venous blood. The absorption curves for both forms have strong bands inthe visible part of the spectrum. The molar extinction coefficient in the “blue” region spectrumis very high at the 405 to 420 nm band (reachingvalues higher than 500 mM-1cm-1).

Therefore,incident radiation in this range will be very highly absorbed by blood, and the penetration of light the papillary dermis will be very difficult because of the presence of a plexus of blood vessels.Thus, all ef blue light in the 400 – 450 nmspectral region will be superficial due to the lack ofpenetration because of bl also because of the presence of melanin Moving from the 400 nm range to the 500 nm range shows a dro absorption by HbO2 and then a sub sequent increase producing two absorption peaksat 538 and 578 nm peaks have the E values of approximately 53 and 55 mM-1cm-1, respectively.

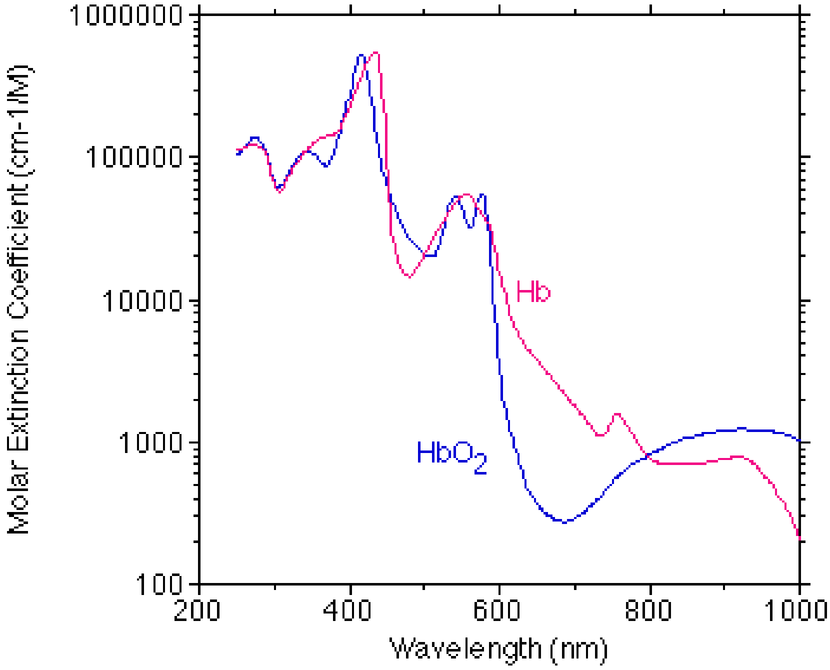
The Hb has a single peak centered at ~550 nm, with maximum of ~54 mM-1cm-1. This is an order of magnit than the deep blue region around 400nm, but in comparison to longer wavelength regions,this still rep tremendous absorption. Logically, if an equipment designer wants to target blood vessels through out the p dermis, a blue light source in the 400 nm region would limit the penetration too much. A device designed advantage of the secondary absorption peaks at 538 and 578 nm would make a lot of sense. However, as h evident over the years, both Candela and Cynosure have chosen to move their dye laser outputs off of the peak to 585 or 590 nm in order to gain more depth of penetration and producea larger coagulative effect. peak of 578 (with an E of ~55 mM-1cm-1),the molar extinction coeffecient of the oxy-hemoglobin drops mM-1cm-1at 600 nm. The 22 nm difference between the wavelengths produces a 17-fold drop in absorption value drops evenfurther, down to about 0.3 mM-1cm-1, between 700to 800 nm. We often speak of an ad absorption peak for hemoglobin in the 900 to 1000 nm range, but by looking at the curves, the E only approximately 1.2 mM-1cm-1. Although this is a 4-fold increase from a low of 0.3 mM-1cm-1, it is al significant when compared to the absorption of hemoglobin in the 525 to 580 nm region.Continuing to wavelengths, the E drops below ~0.3 mM-1cm-1at 1,064 nm. One can conclude that there is no selectivity a blood absorption at the longer wavelengths.

Therefore, the only explanation for the coagulative ability of 1,064nm in treating blood vessels is the non- thermal effects of heating the tissue in a localized area. This will be discussed in more detail later.

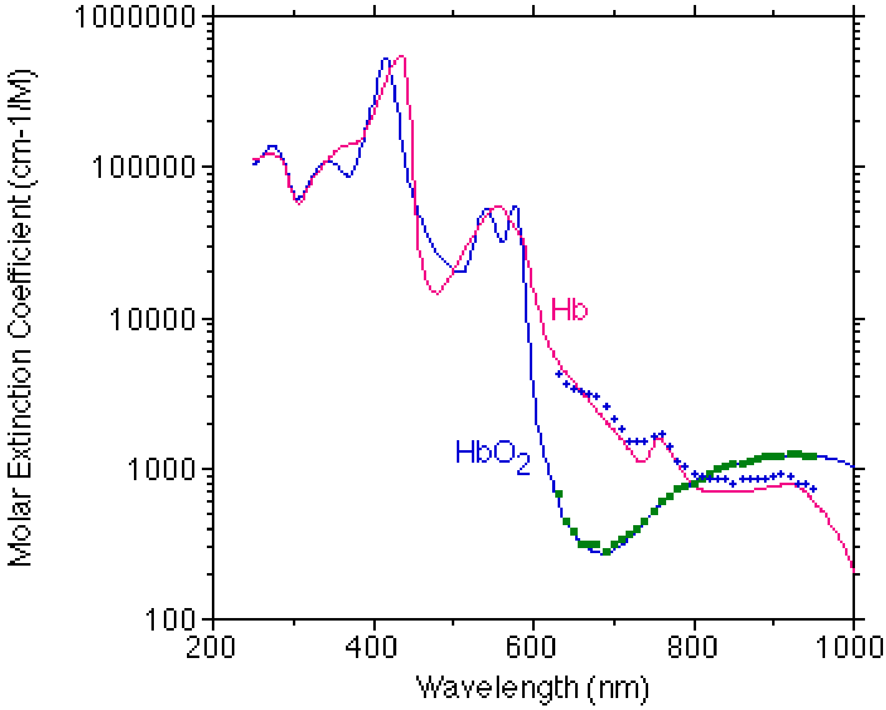
Wavelength Choice

Distribution of chromophores in a tissue will determine the absorptive characteristics of the tissue.It should in mind that most relevant tissues also scatter light, and scattering characteristics canbe very important in the resulting energy distribution in the tissue. However, in this work we shall not concern ourselves v scattering properties. Strictly speaking, is only valid for homogeneous distribution of a chromophore material.If chromophore is concentrated in “lumps” (as, forexample, hemoglobin in erythrocytes or inmelanosomes), other effects, such as “sieve effect”will influence the resulting absorption characteristics.

Spectra



A best estimate of the spectrum of Hb and HbO_2 from a variety of sources by Scott Prahl. A tabulation of the data is avail



Comparison of Moaveni's data (with my compiled values (curve).

PHLEBOTOMY

Phlebotomy is the practice of using a needle to withdraw a sample of blood from a designated vein. In earlier times, phlebotomy was called bloodletting. It was used to treat and/or cure diseases. Phlebotomy today is also called venipuncture or venopuncture. A phlebotomist is a person who performs phlebotomy.

The type of blood cells found in the peripheral blood smears may be of diagnostic and prognostic importance. For this reason proper preparation and staining of blood films is essential for the identification and study of different kinds of leukocytes. The appearance of erythrocytes and thrombocytes will often give important clues that help distinguish between different types of diseases or other physical changes.

According to a recent study, it has been estimated that there are nearly 500 million venipunctures done every year. Other studies have shown that 95.2 - 97.3 percent of them are successful in the first attempt which indicates that it is difficult to find veins in around 14 million cases on the first try. Also, 15,000 patients per day are subject to 4 or more attempts to draw blood or other fluids from the vein causing them to experience a lot of discomfort and pain. Patient's comfort takes priority and avoiding multİple needle sticks is essential. In an emergency setting because of most cases its not crucial.

Venipuncture

Venipuncture is the method by which blood is drawn in most cases, and it may also be called phlebotomy or a blood draw. It refers to using a needle to pierce the skin and to access a vein so that a small amount of blood can be removed for various studies. Most people will experience venipuncture at some time in their lives, to either test for disease or to evaluate the various elements in blood that might indicate poor health.

The majority of adults will have blood drawn from the inside of the elbow, where the phlebotomist or other medical technician or specialist can access the median cubital vein. The standard method is to insert a needle through the skin and into this vein, which may first be slightly enlarged by using a tourniquet for a minute.

Blood is then usually extracted by using a special vacuum tube that will hold the blood until it has various tests performed on it. Since people may require several tests from a single venipuncture, more than one vacuum tube may be used to collect the blood, but this doesn't tend to require more than one puncture. In rare instances, a syringe method is used to collect blood instead, but the vast majority of venipuncture types use the vacuum tube.

Young children may have venipuncture done in different areas, including the hand or foot. Though this is more painful, it is usually easier to access the surface veins on infants and children from these areas. Patients or their parents can sometimes have a preference here, and moms or dads could advocate for a venipuncture performed on the median cubital vein instead, especially if a child is over a couple of months old.

For the person experiencing a blood draw, especially one fearful of needles or alarmed at the sight of blood, it can seem like the multiple tubes used to collect blood collect a lot of blood. Actually samples taken tend to be very small, though they may not look it. A single vial might contain 5 milliliters, which is equivalent to a teaspoon. This should be compared to the amount of blood a person could voluntarily donate. It takes roughly 29 milliliters to make up an ounce, and the standard blood donation is approximately 16 ounces or 473.2 ml. Though it can seem like a lot, even if several vials are used, usually no more than an ounce of blood is lost, one-sixteenth of a voluntary blood donation.

Venipuncture also occurs when people have IV (intravenous) lines started. In most cases, the skin must be pierced and a vein accessed so that fluid or medicines can be administered intravenously. The procedure for this is slightly different, and can be more involved. However, when an IV line is present, blood draws may occur through this open access, instead of having to perform additional venipuncture procedures, which can be useful in hospital settings where blood tests might be required frequently.

Sizes and Types of Needles

Venipuncture with evacuated or vacuum tubes:

Vacuum tubes were first marketed by U.S. company BD (Becton, Dickinson and Company) under the trade name Vacutainer tubes. Today, many companies sell vacuum tubes as the patent for this device is in the public domain. Some models are a type of test tube that contains a vacuum that automatically aspirates blood into itself. The tubes are made of glass or plastic. The tubes are attached to a needle and hub.

Multiple vacuum tubes can be attached to and removed in turn from a single needle, allowing multiple samples to be obtained from a single procedure. This is possible due to a Japanese invention called the multiple sample sleeve, which is basically a plastic cap fitting over the posterior end of the needle cannula, thus keeping blood from draining onto both health care worker and patient.

BD used this invention to create a system that included the vacuum pressurized sleeve, and a cannula with sleeve attached to a holder that holds the needle/sleeve combination, and guides the negatively pressured collection vial that is inserted once the needle is in the patient. Unfortunately, the sleeve that stops blood from moving until its seal is perforated by the collection tube's insertion, also prevents flashback, the tell-tale sign the vein has been entered properly. If the phlebotomist chooses to use a butterfly needle, the "flash" is still present, and easily visible to the phlebotomy tech as well as the patient.

They are commonly used in US, UK, and Australian hospitals, private doctors' offices and community labs, and are available in various sizes to suit the age of the patient and the type of sample needed.

Venipuncture with butterfly needle

The smallest needle, the butterfly needle, is used most commonly for infants. This needle is also used for patients with small, hard to find veins. Most lay people are under the impression that using a butterfly needle and less painful. Using a finer needle is less painful. However, the hazard of using butterfly needles lies in the fact that as the blood flows through the rubber tubing, it cools significantly, thereby clotting faster. In clotting in the tube, it stops up and reduces or as in most cases, completely stops.

When this happens, it is necessary to re-stick a patient in order to obtain the blood sample. This is not the case when using the more common needles. Since the tubing is not a part of the needle, the blood goes through the needle directly into the tube. This method results in a faster, cleaner sample with less chance of haemolysis. (When a blood sample is hemolyzed, it means the red cells have ruptured to the extent that they impart a pink/red color to the blood plasma, which is normally pale yellow.) .

Venipuncture with needle and syringe

Some health care workers prefer to use a syringe-needle technique for venipuncture. Sarstedt manufactures a blood-drawing system S-Monovette that uses this principle. This method can be preferred on elderly patients, oncology patients, severely burned patients, obese patients or patients with unreliable or fragile veins. Because syringes are manually operated, the amount of suction applied may be easily controlled.

This is particularly helpful with patients that have small veins that collapse under the suction of an evacuated tube. In children or other circumstances where the quantity of blood gained may be limited it can be helpful to know how much blood can be obtained before distributing it amongst the various additives that the laboratory will require.

Fingersticks

There are different sized needles for different sized patients and for different situations. Fingersticks are tiny needles used to stick one of the four fingers; usually, this is done to get a glucose measurement in cases of hyperglycemia or hypoglycemia. Fingersticks are also often used to draw blood from children.

Needle Informations:

Colour	Size	mm	Max flow/min (length)	Common uses
Orange/brown	14g	2.0	265mllmin (l=42mm)	Rapid transfusions, blood
Grey	16g	1.7	170mllmin (l=42mm)	As above
Green	18g	1.2	90mllmin (l=40mm)	IV maintenance fluids
Pink	20g	1.0	55mllmin (l=32mm)	IV drugs/infusions
Blue	22g	0.8	25mllmin (l=25mm)	Paediatrics/difficult veins.

Reasons for Drawing Blood

Transfusion

Phlebotomists also obtain blood from people so that patients with large losses of blood can receive blood by transfusion. People who have been in major accidents, who have diseases such as hemophilia, who have abnormal menstrual flow or who are pregnant all benefit from the practice of phlebotomy.

Lab Tests

Phlebotomists also take samples of blood to send to lab scientists and technicians. Lab technicians study the blood to find the anomaly and cause of certain diseases, such as, cardiovascular disease, artherosclerosis, hemophilia or AIDS. The results of blood tests enable doctors to diagnose and treat disease.

Forensic Testing

Another field of phlebotomy is forensics, where criminal pathologists examine the blood of crime victims to determine the exact cause of injury and/or death. Phlebotomists also are given the task of insuring that all blood samples are guarded safely against contamination and/or tampering.

Patient Assessment

Factors Influencing Vein Choice

*Age of patient
*Previous uses and condition of the veins
*Clinical status of patient e.g. Dehydrated, shock, amputee, mastectomy, oedema, thrombocytopenia, CVA
*Other clinical procedures required during admission
*Type and length of treatment
*Medications: warfarin, heparin, steroids
*Patient preference
*Patient co-operation, previous experiences
*Try to use non dominant arm

Clinical Related(Phlebotomist&Nurse)

*age
* years experience as an RN
* years experience inserting IVs
* number of IV's inserted per week
* self-rated IV skills
* specially certification[5]

Condition Of Vein

<u>A good vein is:</u>

• Bouncy

- Soft
- Refills when depressed
- Visible
- Has a large lumen
- Well supported
- Straight

A void veins which are:

- hypotension
- peripheral vasoconstriction
- anemia
- Thrombosed / sclerosed / fibrosed
- Inflamed / bruised
- Hard
- Thin / Fragile
- Mobile / tortuous
- Near bony prominences, painful
- Areas or sites of infection, oedema or phlebitis
- In the lower extremities (unless none else available)
- Have undergone multiple previous punctures

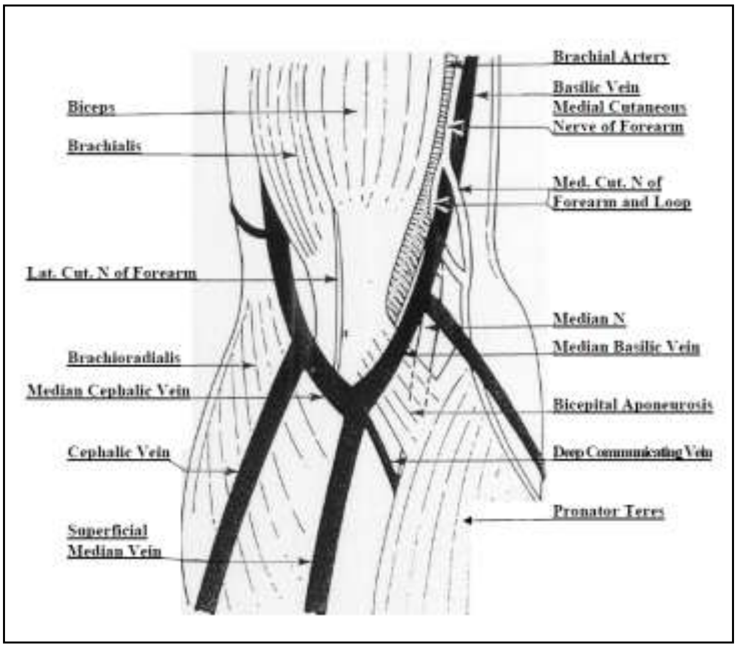
Improving Venous Access

- Application of a tourniquet promotes venous distension. The tourniquet should be tight enough to impede venous return but not affect arterial flow.
- Lower the extremity below the level of the heart
- Use muscle action to force blood into the veins - e.g. open and closing of the fist
- Light tapping of the vein
- Apply warm compresses or immerse limb in bowl of hot water to increase vasodilatation
- Consider GTN Patch.

Appropriate Sites For Phlebotomy

Antecubital Fossa

The antecubital fossa is the area of the arm near the elbow. This area is in the front of and below the bend of the arm at the elbow. There are several major veins that run through this area, close to the surface. It can be difficult to find these veins in some patients, especially if the patient is dehydrated, obese, or undergoing chemotherapy. These conditions effect determination of veins.



Antecubital Fossa

Three Primary Veins

There are three veins most commonly used in venipuncture, or phlebotomy. They are the cephalic, median cubital, and basilic veins. These three veins are found in the antecubital area. The cephalic vein is found on the lateral, or outside, of the arm. The median cubital vein, the preferred one to use, is found close to the center, and the basilic vein is located on the inner, or medial part of the antecubital area.

a)Median Cubital

The median cubital vein is the preferred vein for phlebotomy because it is usually larger than the other veins and more stationary. Veins can move, or roll, which makes it more difficult to perform phlebotomy. The median cubital is typically well anchored, which makes it less likely that the patient will feel pain during phlebotomy, or bruise afterwards.

PRO's

- Large veins and so they will readily accept a large cannula.
- Do not "shut down" as quickly as the more peripheral veins.
- First choice in the emergency situation.

CON's

- Can be very positional due to elbow flexion/extension.
- Can be very uncomfortable for the patient due to elbow flexion/extension.
- Care must be taken not to cannulate the brachial artery.

b)Basilic Vein

The basilic vein is located in the upper limb and functions to draw blood from the hands and arms. It originates from the back of the hand, curves around the central forearm and continues upward, along the arm, to connect with the axillary vein (the blood vessel that supplies blood to the heart from the thorax and the axilla). This superficial (close to the epidermis of the skin) vein travels through the fat posterior to the muscles of the upper limb. It is visible through the skin and appears as a deep-blue structure when viewed by the naked eye. The basilic vein is the most common site for venipuncture.

PRO's

- A large vein that is frequently overlooked in the hunt for veins.

CON's.

- Requires awkward positioning of the limb to gain access to the vein.
- The vein tends to roll away when you attempt to cannulate it.
- Sites prone to phlebitis.
- Cannula port gets caught on sheets.

c) Cephalic Vein

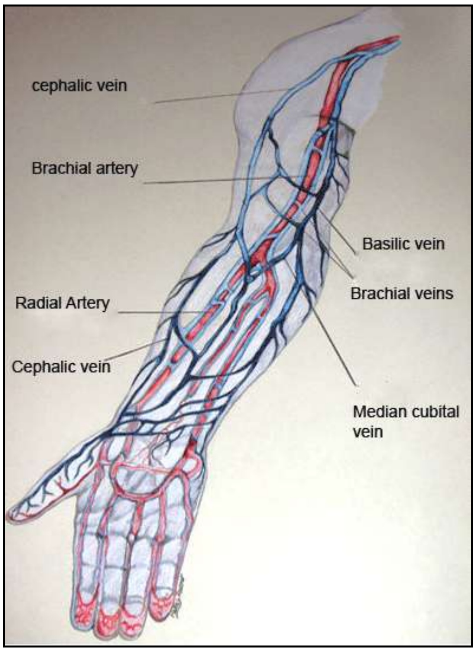
Forms from a confluence of veins at the base of the thumb and passes upward along the radial (lateral) aspect of the forearm to enter the lateral part of the antecubital fossa.

PRO's.

- Readily receives a large cannula and is therefore a good site for blood administration.
- Splinted by the forearm bones.
- Cannula is easily secured.

CON's.

- Can be more difficult to cannulate than the metacarpel veins.
- May be confused with an aberrant radial artery.



Anatomy of veins

Hand Veins(Metacarpal Veins)

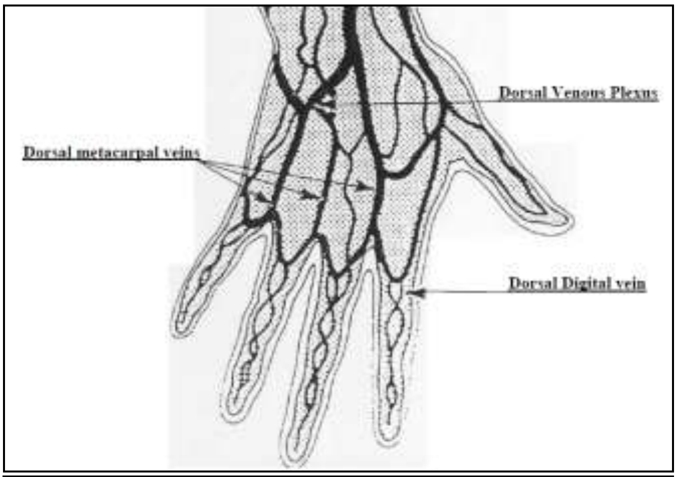
At times, none of the veins of the antecubital fossa will be felt. They also may not be able to be used due to intravenous placement or injury. Hand veins may be used if it is not possible to use the antecubital veins. Veins of the hand and wrist are usually close to the surface, but they are prone to movement and rolling. Using these veins tends to be more painful for the patient, since there are nerves running through the hand as well. If using these veins, it is important to anchor the vein with your hand, holding it in place, when you are drawing the blood.

PRO's

- Easy to see and palpate veins.
- Splinted by metacarpal bones.
- Allows use of more proximal veins in the same limb should the cannula need to be re-sited.
- Cannula is easily accessible in the theatre environment.

CON's

- Active patients may dislodge easily.
- Dressing may be compromised by handwashing.
- May be more difficult if the skin is thin and friable.
- Flow can be affected by wrist flexion or extension.



Metacarpal veins

Other Veins

Veins of the legs, ankles and feet should preferably not be accessed as blood coming from the inferior limb veins can undergo changes in coagulability mainly due to passage down atherosclerotic plaques in the arteries.Veins of the legs, feet, and ankles cannot be used without specific permission from a physician. Usually if these veins are to be used, the physician will draw the blood. There is the potential for blood clots to form when these veins are used. A particular case is external jugular venipuncture in the neck, which can be performed in surgical or emergency settings

Step And Step Injection Or Blood Drawig Process

Veinpuncture

a. Site

To obtain blood by venipuncture, draw the specimen directly from a patient's vein with a sterile hypodermic needle and syringe or a vacuum blood sample device. In adults use the veins located in the proximal forearm or antecubital space as illustrated in figure 1. In infants employ the jugular or femoral vein for the venipuncture.

The vein selected should be large, readily accessible, and sufficiently close to the surface to be seen and palpated. If venipuncture poses a problem due to the age of the patient, sclerotization due to repeated venipuncture, or any other unusual circumstance, the technician should consult a physician concerning the procedure. Under no cırcumstances should a technician wıithdraw blood from a sagittal sınus, jugular vein, or femoral vein.This should be left to the discretion of the physician in charge. Occasionally, the best vein is found on the hand, leg, or foot. These areas are more sensitive, and the veins are not as firmly anchored as those of the arm. Veins can become distended and easier to enter by allowing the arm to hang down for 2 or 3 minutes, by massaging the blood vessel toward the body, or by gently slapping the site of puncture. Young and vigorous persons usually have elastic veins well filled with blood. Elderly or debilitated persons can have sclerosed or fragile veins, which are hard to enter or which collapse easily.

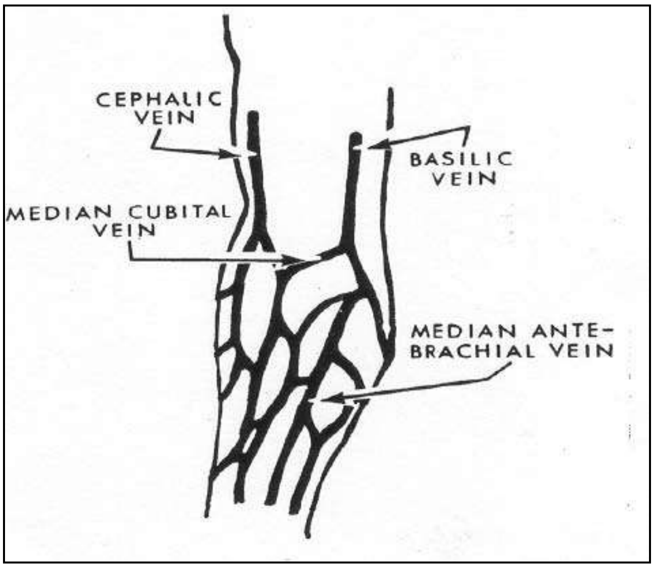


Figure 1. Site of venipuncture.

b. Equipment.

All syringes, needles, lancets, and other instruments used for the collection of blood specimens must be sterile. Disposable syringes or blood collection sets with vacuum tubes are available through normal supply channels. These should be used whenever possible. Aseptic technique is necessary to prevent the possible transmission of homologous serum hepatitis. The following equipment is necessary to perform a venipuncture:

(1) Isopropyl alcohol, 70 percent, prep pads.

(2) Tourniquet.

(3) Sterile syringes or vacuum blood sample devices.

(4) Gauze pad, 2 x 2 inches.

(5) Needle, 1 to 1 ½ inches long, 19–23 gauge.

(6) Suitable blood collection tubes and labels.

(7) Gloves, latex.

c. Preparation

(1) Cleanse hands thoroughly with soap and water.

(2) Place an identifying label on the blood collecting tube.

(3) Assemble the sterile needle and syringe. If a vacuum system is used, screw the needle into the plastic holder. Always leave the cap over the needle when not in use.

(4) Check to be sure that the syringe works smoothly. The syringe must be dry to avoid hemolysis of the red cells. The plunger must match the syringe and must be pushed firmly to the bottom of the cylinder to prevent injection of air into the vein. This can be fatal.

d. Syringe Procedure

(1) Place a tourniquet around the patients arm above the elbow tightly enough to check venous circulation, but not so tightly as to stop arterial flow. (If latex tubing is used, place it approximately 2 inches above he proposed venipuncture site). Form a loop with the longer end and draw the loop under the shorter end so that the tails of the tubing are turned away from the proposed site (see figure 2).

CAUTION: Do not allow the tourniquet to remain in place for more than 2 minutes.

Check the pulse at the wrist to make sure that arterial circulation is not cut off.

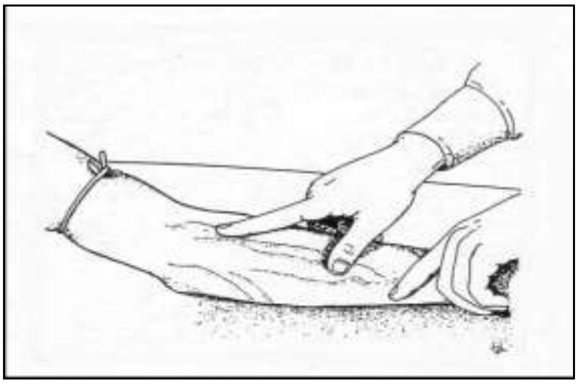


Figure 2. Venipuncture procedure: Locate the vein.

(2) Instruct the patient to make a tight fist.

(3) By inspection and palpation locate the desired vein, determine the direction of its course, and estimate its size and depth (see figure 2 venipuncture procedure, a through h).

(4) Release tourniquet.

(5) Cleanse the skin over the selected vein with prep pads in 70 percent isopropyl alcohol. Wipe off excess alcohol with a sterile dry gauze. Do not contaminate the area after cleaning (see figure 3).

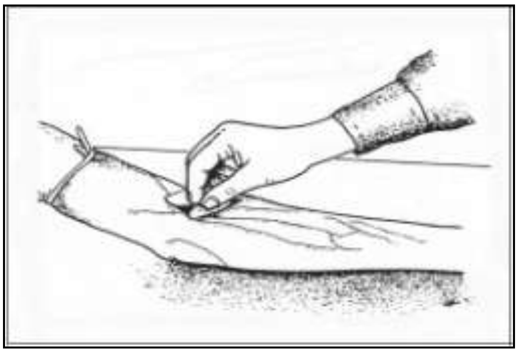


Figure 3. Venipuncture procedure: Clean the puncture site.

(6) Put on gloves.

(7) Replace tourniquet on arm and have the patient straighten out the arm and make a fist.

(8) Grasp the syringe in the right hand and place forefinger on the hub of the needle to guide it. Grasp the forearm with the left hand about 2 inches below the area to be punctured and hold the skin taut with the thumb (see figure 4).

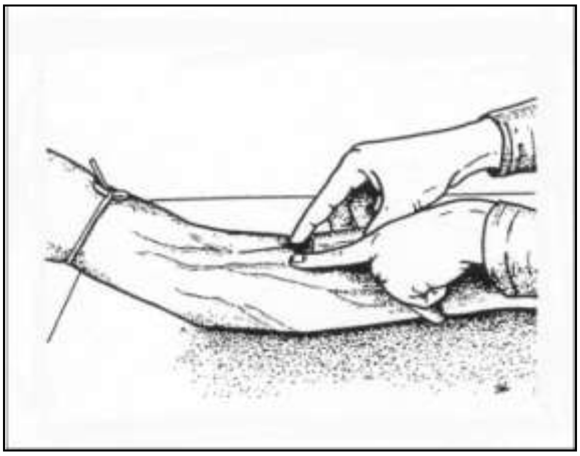
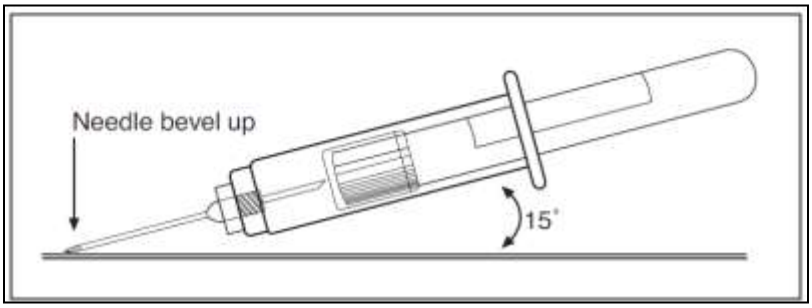


Figure 4. Venipuncture procedure: Guide needle toward the vein.



The needle should be at about a 15-degree angle with the skin

(9) With the needle bevel up, parallel to, and alongside the vein, insert the needle quickly under the skin and then into the vein. The insertion into the skin and vein can be performed in one complete motion (see figure 5). After entry into the vein, blood will appear in the needle hub. Do not probe or move the needle horizontally, as discomfort and possible nerve damage may result.

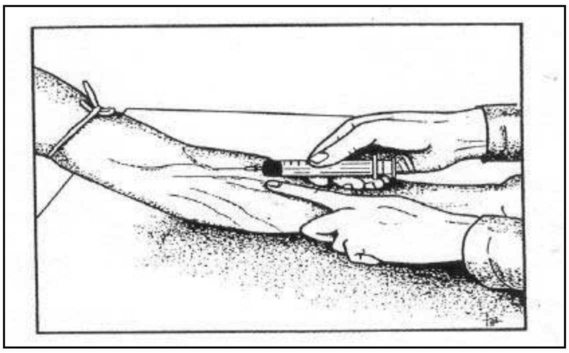


Figure 5. Venipuncture procedure: Insert needle into the vein.

(10) Aspiration of the blood is accomplished by gently pulling upon the syringe plunger (see figure 6). The syringe barrel should be held steady during this process. Withdraw the desired quantity.

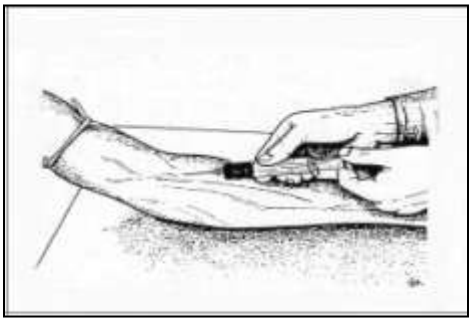
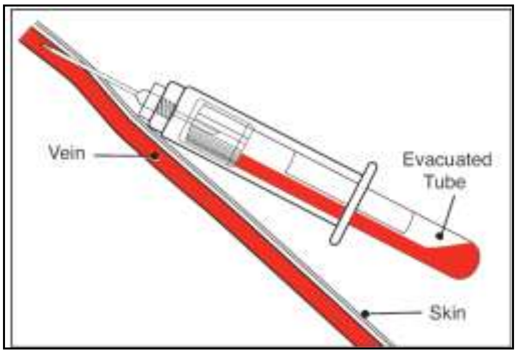


Figure 6. Venipuncture procedure: Aspirate the blood.



Entering to vein

(11) Remove the tourniquet by pulling on the long, looped end of the tubing only after blood is drawn into the syringe (see figure 7).

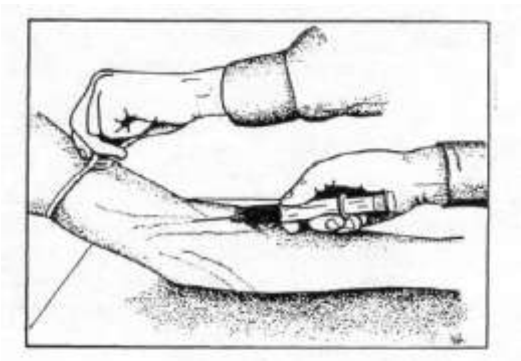
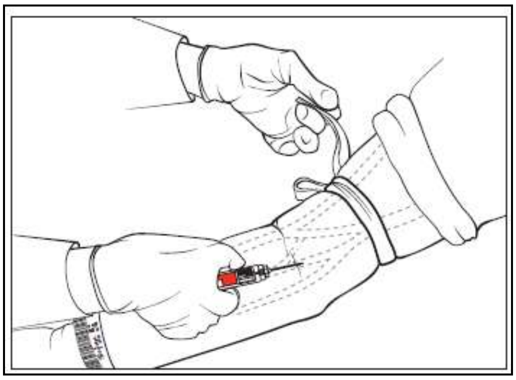


Figure 7. Venipuncture procedure: Remove the tourniquet.



The tourniquet must be removed before withdrawing the needle from the puncture site.

(12) Place a sterile gauze pad over the point where the needle entered the skin and deftly withdraw the needle simultaneously putting pressure on the site (see figure 8).

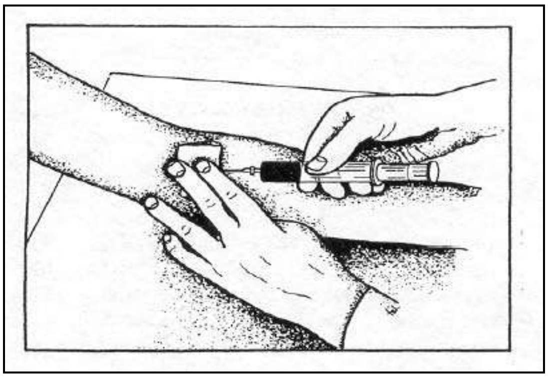


Figure 8. Venipuncture procedure: Place a sterile pad over the site and withdraw the needle.

(13) Have the patient extend the arm and maintain light pressure on the gauze pad over venipuncture site (see figure 9).

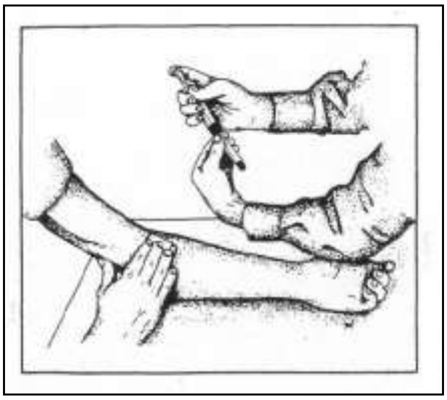
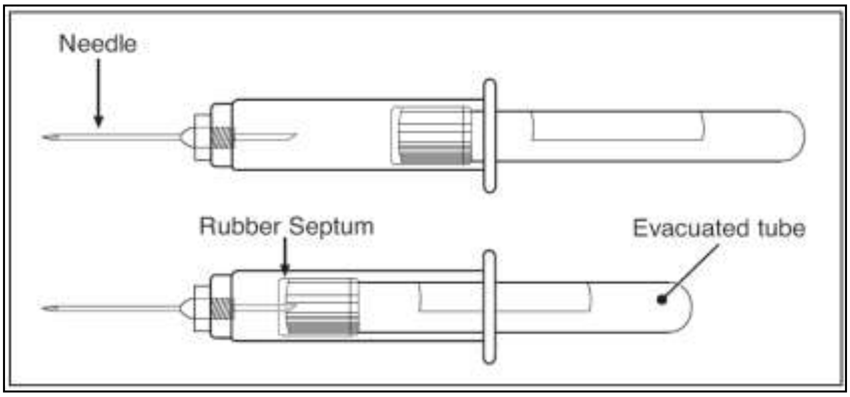


Figure 9. Venipuncture procedure: Have the patient extend the arm and maintain light pressure on the site.

e. Vacutainer Procedure.

(1) Place the Vacutainer tube in the holder until the rubber stopper reaches the guideline. The short needle should be embedded in the stopper, but the needle must not break the vacuum.



Vacutainer tube and needle

(2) Follow steps as needle.

(3) Enter the vein with the needle parallel to and alongside the vein. Probing or horizontal movement of the needle while under the skin must be avoided.

(4) After entry into the vein push the tube all the way into the holder; vacuum is broken, and blood flows freely into the tube. Release the tourniquet at this time by pulling the long, looped end of the tube.

(5) If the multiple needle is used or more than one tube is required, release the tourniquet after the first tube is filled; remove the filled tube and insert the next one.

(6) Place a sterile gauze pad over the point where the needle enters the skin and deftly withdraw the needle, placing pressure on the site.

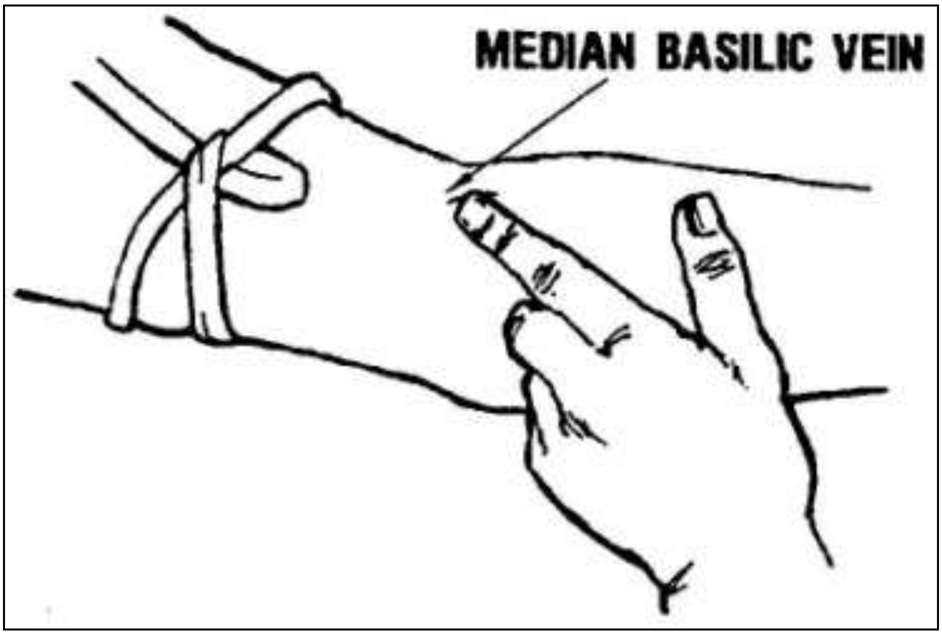
(7) Have the patient extend the arm and maintain light pressure on the gauze pad over the venipuncture site.

Locating the Vein

Develop your sense of touch when it comes to finding veins. If you rely on site alone and never strengthen this skill, you'll have difficulty finding veins on many of your patients. Practice finding veins without using you eyes at all. Practice this skill while wearing gloves.

If you have trouble locating a patient's vein, try one of several tricks. First, replace the standard tourniquet with an inflated blood pressure cuff. If this is not successful, have the patient dangle her arm at her side while you prepare a warm compress. Heat can often bring a vein to the surface. You alos can try gently rubbing or tapping the area, however, it is a myth that slapping the area is appropriate. Slapping the site of puncture can hemolyze the surrounding blood cells and render some tests inaccurate.

Do not have the patient pump her fist in order to assist you in finding a vein. This has been known to increase potassium and can interfere with the accuracy of lab test results. [24]



palpation of vein

Common Vein Disorders

What is a telangiectasia?

A telangiectasia is a confluence of dilated intradermal venules of less than 1 mm in caliber. Telangiectasia are more commonly known as spider veins and thread veins. They can be pink, red, purple and blue. Spider veins occur in 15 % of men and 25 % of women in the general population.In the classification of veins, telangiectasias are classified as type I veins. Spider veins can treated withlaser therapy and sclerotherapy.

image of a telagiectasia

What is a reticular vein?

A reticular vein is a dilated bluish intradermal vein, usually from 1 mm in diameter to less than 3 mm in diameter. They are usually tortuous. Reticular veins are also known as blue veins and intradermal varices. In the classification of veins, reticular veins are considered type III veins. Telangiectasias (type I veins) can result from refluxing reticular veins.

When such reticular veins are associated with telangiectasias, they are called "feeder veins". If sclerotherapy is chosen as the treatment for a particuar patient, the reticular veins should be injected first and the telangiectasias last.

image of reticular vein

What is a varicose vein?

A varicose vein is a subcutaneous dilated vein larger than 3 mm in diameter in the upright posture. Varicose veins are also known as varix, varices and varicosities. Varicose veins can occur in ten quadrants: anterior thigh, medial thigh, lateral thigh, posterior thigh, anterior leg, medial leg, lateral leg and posterior leg. They can also occur in the medial and lateral ankle.

image of varicose vein

Varicose veins pool blood in stagnant segments and get inflamed causing chronic phlebitis. If these symptoms of aching, pain, itching, burning and cramping are not relieved with use of compression stockings, they are amenable to the latest techniques that we employ at the Vein Treatment Center. Techniques include a combination of endovenous ablation procedures to treat underlying venous insufficiency (venous reflux disease), microphlebectomy and dynamic foam sclerotherapy.

What is Corona Phlebectatica?

A fan shaped pattern of small intradermal veins on the medial (inside) or lateral (outside) aspect of the ankle and foot is called corona phlebectatica. Corona implies that they "crown" the ankle. Corona phlebectatica is thought to be an early sign af advanced venous reflux disease. This reflux typically originates at the saphenofemoral junction with venous blood refluxing into the great saphenous vein. Less commonly, saphenopopliteal reflux into the lesser (short) saphenous vein is the underlying cause of corona phlebectatica. Other names for corona phlebectatica include "malleolar flare" and "ankle flare" .

image of chronic corona phlebectatica

What is Edema?

Edema is tissue fluid in the skin and subcutaneous (fat) and is measured by the amount of skin indentation left with digital pressure. It is associated with venous reflux disease.

image of chronic Edema

What is Stasis Dermatitis?

Stasis Dermatitis is a type of dermatitis related to chronic venous reflux disease and inflamed varicose veins. It can be a blistering, weeping or scaling skin eruption and occurs in the legs. Stasis dermatitis is also called gravitational eczema and venous eczema. Gravitational eczema is what the name implies, eczema in the lowest parts of the leg where there is most effect by gravity, i.e. venous reflux with elevated venous pressures due to this venous load (venous hypertension). Again, stasis dermatitis is most comon in the gaiter areas of the legs. Once the inflamed cords of veins are treated, venous eczema will go away.

image of chronic stasis dermatitis

What is Lipodermatosclerosis?

Lipodermatosclerosis is chronic inflammation with resultant fibrosis of the skin where the skin of the lower leg becomes scarred in a circumferential manner and the leg looks tapered like the 'chicken leg'. Lipodermatosclerosis has been identified under many different names for years, as membranous lipodystrophy, lipomembranous fat necrosis and stasis associated lipomembranous panniculits, among others. The hallmark of lipodermatosclerosis is the leathery skin, brown discoloration, hyper and hypopigmentation of the skin, and circuferential or near circumferential scarring and shrinking of the extremtiy.

image of advanced lipodermatosclerosis (chronic)

image of chronic lipodermatosclerosis

image of chronic lipodermatosclerosis

POSIBBLE SOLUTIONS TO OVERCOME THE DRAWBACKS TO DETECTION OF VEINS

Most of people to have to need veinpuncture(taking blood-phlebotomy) but some reasons couldn't find and poking so that a clinician can put something into, or take something out of, our circulatory systems.

For some people, this can be an agonizing process as poor vascular quality leads to clinicians poking and prodding the patient's extremities to try and find an adequate vein.

This procedure will soon be a thing of the past as Our trademark Blood **Ves**sel **Loc**ator**(Vesloc),** Trademark of our group Vesloc has launched the improved handheld vein illumination device for healthcare workers.

In contrast to current large, portable, vein illumination technologies, the size and portable ability the Vesloc means that this device is just as much more than at home in an ambulance as it is in hospitals area.Also personality usage to give advantage of workers area.

What is posible solutions to overcome the drawbacks of vein?

If we try to solutions to overcome to the detection we know the problems and then find solutions.

Difficulties and Problems

In obese patients; the main problem for injection or blood drawing is, the existence of substantial deposits of subcutaneous fat. The fat makes it difficult to locate veins by touch or vision. Adipose tissue make hard to taking appearance of veins. Solution of this visible of vein with obese patients overcome problems

If nurse or phlebotomistis trained well for able to differentiate veins and adipose tissue **for succesful injection and blood drawing.** No need for well trained of and also attribute of the nurse training to find easly no need more training also.

Geriatric patients have veins which can collapse easily due to loss of their elasticity while pediatric patients possess veins that are taut but fragile and very small in size. If can we see vein clearly we can solve easly our device seems the vein easly

For pediatric, particularly vein locations are challenging. Because most of them are apprehensive and do not cooperate with nurses and phlebotomistis.

Generally, patient veins narrowing because of anxiety, Its causes the patient's blood pressure to rise. This narrowing in vein is greater issue for childrens, they already have small sized and narrow veins.

Vieving of vein reduce of anxiety of patient reduce of narrowing of veins also reduce of rising up pressure. Expecially children looking of the portable and giving different colour reduce of scare give also reliabity of their family.

The history of previous venipunctures performed on a patient is critical since there is a high probability of patients with previous venipunctures having damaged veins. Rolling veins are one of the major reasons for failed attempts as the vein moves away from the needle insertion site and leads to unnecessary sticks.

With Vesloc, reduce damaged venipuncture of veins.

View of veins reduce of failed attems.

It can be considered that major reasons for the failure in locating veins in a patient are body mass, properties of the vein, anatomy of the site, and the patient's anxiety. In addition to patient-related factors, the competence of the phlebotomist or the nurse plays a vital part İn the success of locating a vein .

Most of these problems our trade mark of group with Vesloc(Blood Vessel Locator) for view of vein and locate with easly and give the patients users and their family give reliability.

Decreasing of timing giving more experiment time and easier of usage and low cost.Returnnig of time and reliability cost give advantage of this device working area

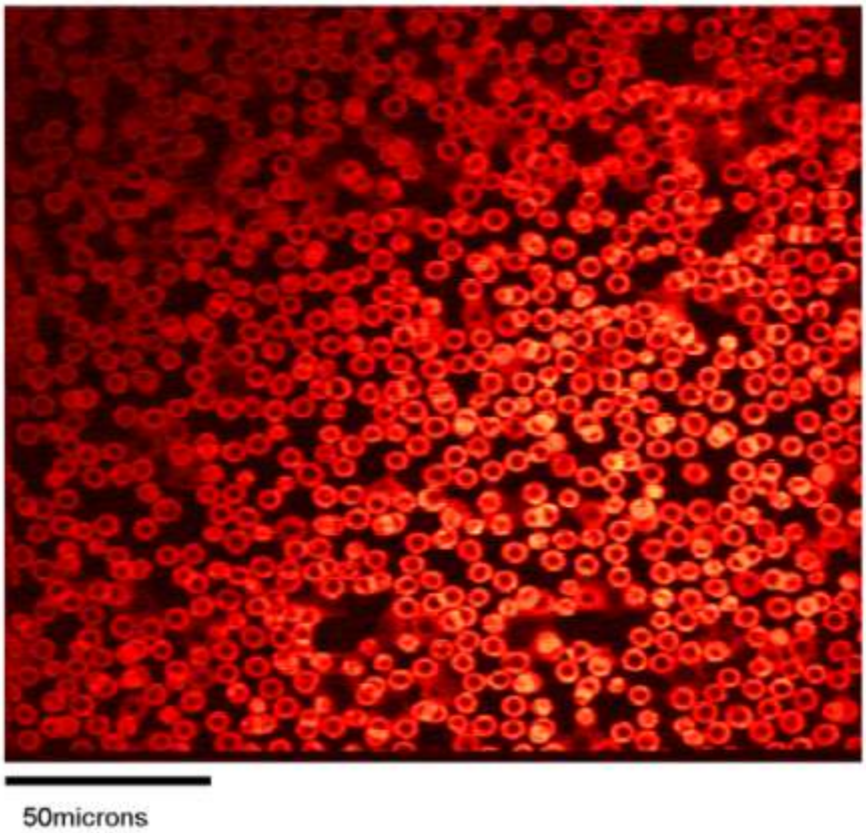
Upgrading Performance of Venipuncture

Palpate and trace the path of veins with the index finger. Arteries pulsate, are most elastic, and have a thick wall. Thrombosed veins lack resilience, feel cord-like, and roll easily.

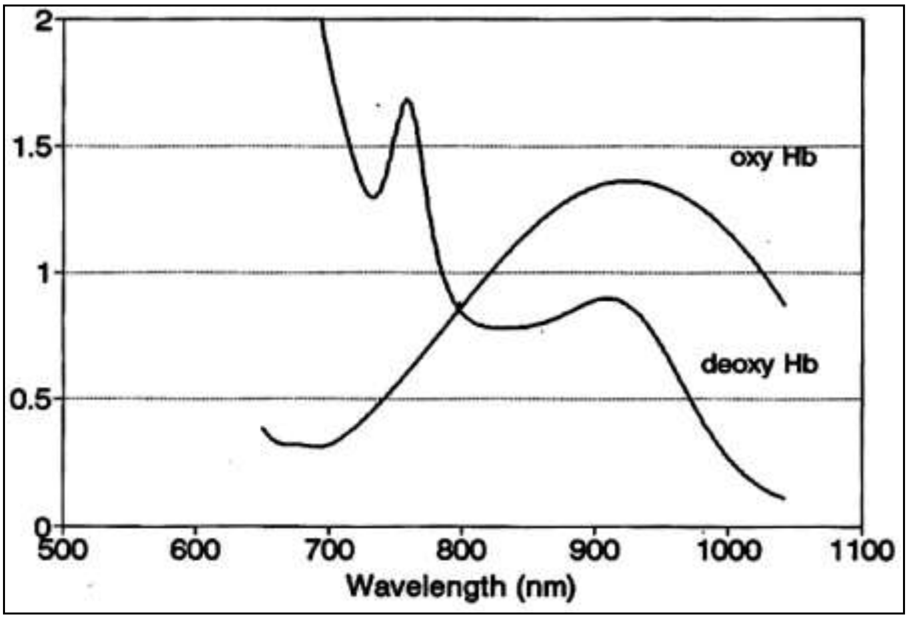
If superficial veins are not readily apparent, you can force blood into the vein by massaging the arm from wrist to elbow, tap the site with index and second finger, apply a warm, damp washcloth to the site for 5 minutes, or lower the extremity over the bedside to allow the veins to fill.

Our trade mark of group with Vesloc(Blood Vessel Locator) using approach the patient in a friendly, calm manner. Provide the patient comfort as much as possible, and gain the patient's cooperation.

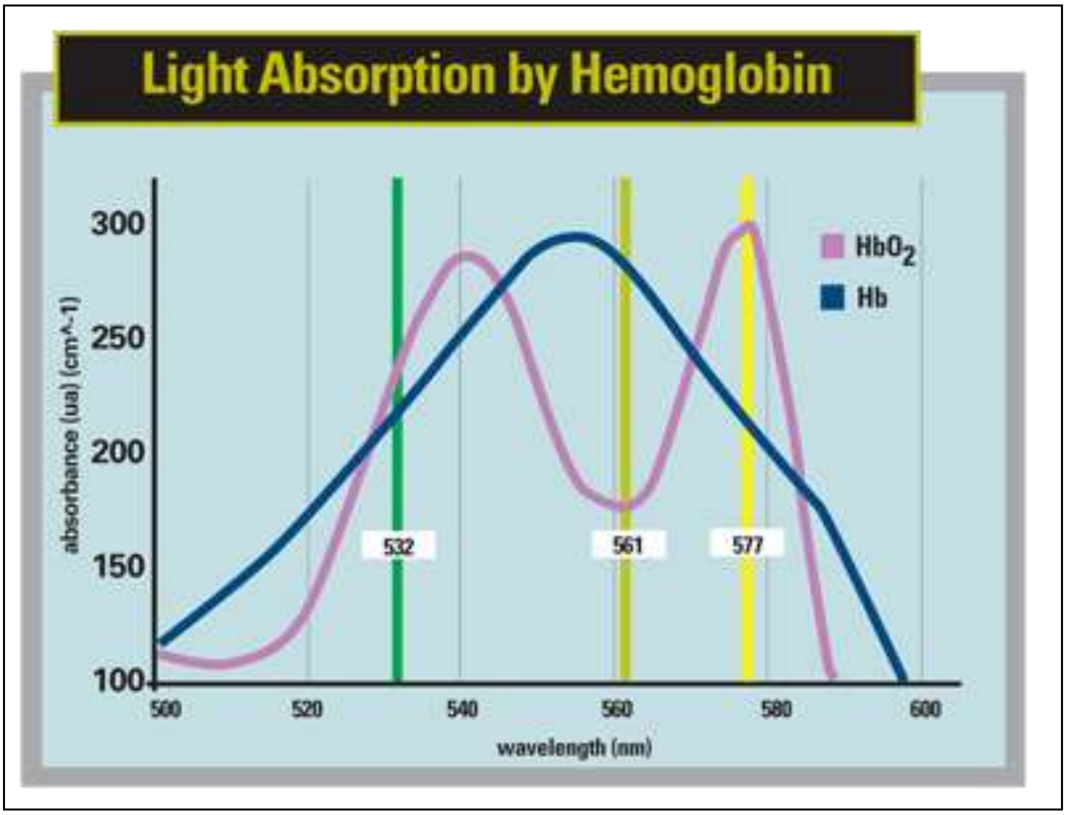
If we looking usage of device give us using very huge area because of our desingning of device using the different wavelength.If you look at the absorption table maximum 560 nm and different tissue different absorbtion Our group Blood Vessel Locator(Vesloc) inculing green yellow and red lazer.Because of give us absorption and reflection using diffent area and different tissues.



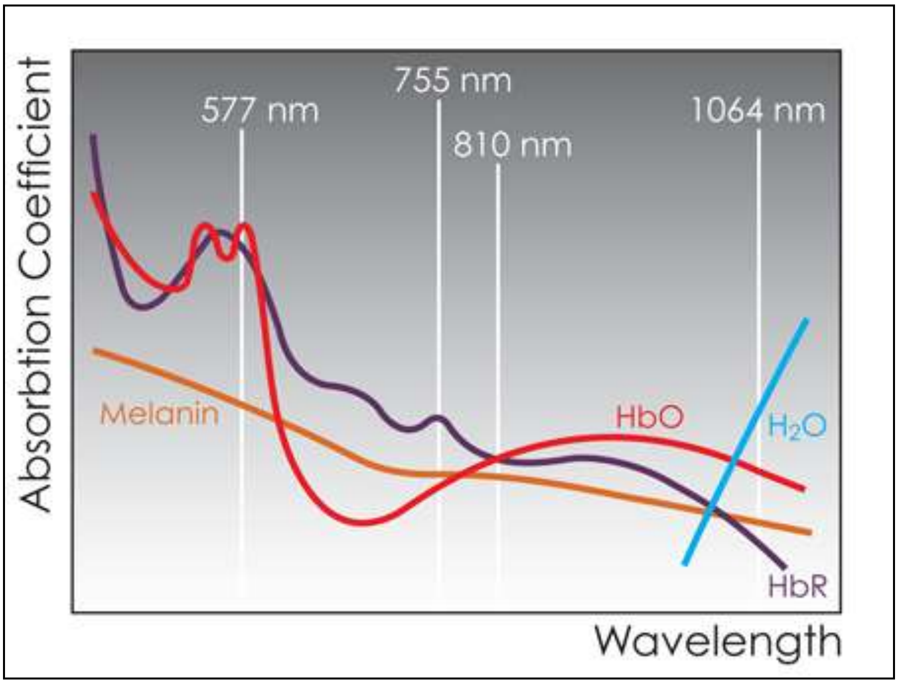
Hemoglobin Distribution in Blood



Absorption spectra of oxy- and deoxy-hemoglobin in near-infrared region.



Absorption Table of Light



As it turned out, however, the existing solid state technology couldn't produce the 577-nm wavelength. "Several lasers on the market today can produce a 561-nm beam that's a greenish-yellow," he notes. "But once you get to 560 nm, you're off the peak absorption for hemoglobin, and you're a little less efficient than the 532s

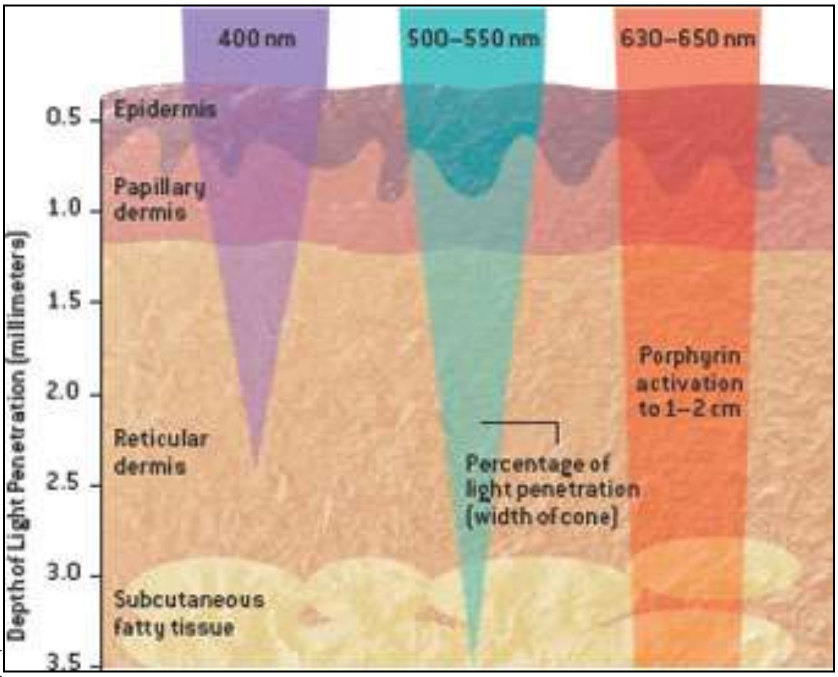
For seeing high quality location of vein this range must be Our trade mark of device (Vesloc) also will include this lazers range

Vesloc will use lasers because give advantages in medicine.

Our designing device also include different button give us separable of veins and arteries.Because of they are emitting different wavelength.

Vesloc is gives very advantages for healtycare and personal care.

[



Absorption of Tissues Dept of Ligth With Different Wavelenght

VESLOC DEVICE DESIGN

- The best wavelength for absorption by hemoglobin was 560 nm.
- Characteristic properties of LEDs at this wavelenght is green colour.
- During experimentation we tried 69 different types and 6 different colour LEDs.
- Finally we deducted that the absoption and reflection of LED light in tissue is most important than the hemoglobin absorption and reflection properties.
- Neither of the green LEDs gave successful results
- White and red LEDs gave best results, with 2 types of LEDs;

  -SMD

  -Power Leds
- With this result, we understand that the penetration is very important such as absorption and reflection properties of tissue.

- 630-650nm wavelenght and upper wavelengths has maximum penetration properties, it means we take good results with red and white leds.
- VESLOC is imanufactured by using white and red LEDs.
- In our Vesloc device, we used SMD LEDs, WHY? ;

- SMD LEDs are very tiny and when we soldered our LEDs there was low height on the boards.

-SMD LEDs have high brightness and penetration property

-SMD LEDs are fairly cheap

-No need for mains power (we tried to design a handy and portable device, because of this reason we could not use bulky power supply, and used a 9V battery)

What is SMD LED?

Definition of SMD LED

Basically an SMD LED is a light emitting diode which is welded and installed on the circuit board. AnSMD LED is quite small, because it has only a tiny packaging around, carrying the standards of the LED. This means that it is easy to be operated, for it is equipped byautomated assembly equipment rather than by person. An SMD LED (LED light emittingdiode) also has a wide viewing angle, and it does not have a standard LED epoxy enclosure,which focuses the beam.

Features of SMD LED

SMD LED provides high brightness, lowers power consumption compared to an OLED light pipe (such as DIP and cluster type LED) and a traditional bulb. Its features are asfollows: Small Size ; SMD LED light source is an enveloped epoxy with a very tiny light emitting chip. Low power consumption: under normal circum stances, the SMD LED voltage is 2 to 3.6V, current is 0.02A to 0.03A. It uses a very low voltage and current.

The power consumption is very low, only the equivalent of 1/8 to 1/4 of the traditional incandescent light source.High brightness: type 3528 SMD and type 5050 SMD high brightness chip single SMD LED 5.5lm/1800 mCD.Long life; under the proper current and voltage conditions, SMD LED works for up to 100,000 hours. Compared with other LED lamps (such as dip LED) light failure in 1000 hours reduced from 10% to 5%.

The Applications of SMD LED

SMD LED gives off very little heat. Its requirements on voltage and current are also very low. As the standard light-emitting diode, the SMD OLED on the surface almost gives off no heat. Italso usually has a similar low voltage and low current requirements.

They are usually used for the state of the art display devices, computer motherboards, routers, hard drives, USB flashdrives and any other applications and its physical space is very valuable. There is also largerspace for its development in computer motherboards, hard drives, routers, flash drives andother applications, including LCD backlight keyboard lights and buttons. They can also beused on airplane dashboards. Some manufacturers have created an SMD OLED lighting solution combined with an SMD resistor, a small circuit board, lens and cable to provide bright, cold LED light to run on 12 volts, which is small enough and can be installed in almost anywhere(for example, light a cup holder). There are other many applications, for example, they are used for the display screen.

You can arrange a lot of red, blue and green group of diodes, resulting in a large variety of colors. This screen technology (AMOLED), which is currently found in shops and shopping malls, have recently appeared in all large outdoor displays.

Power LED

High-power LEDs (HPLED) can be driven at currents from hundreds of mA to more than an ampere, compared with the tens of mA for other LEDs. Some can emit over a thousand lumens. LED power densities up to 300W/cm2 have been achieved. Since overheating is destructive, the HPLEDs must be mounted on a heat sink to allow for heat dissipation. If the heat from a HPLED is not removed, the device will fail in seconds.

One HPLED can often replace an incandescent bulb in a flashlight, or be set in an array to form a powerful LED lamp.

Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

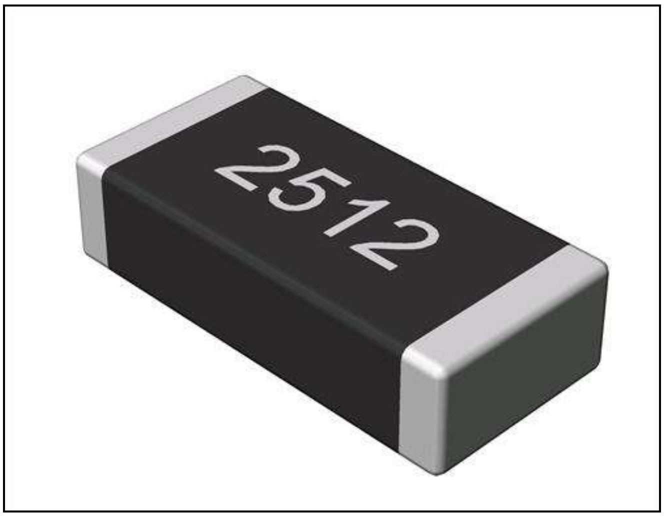
The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$$I = \frac{V}{R}$$

where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms.

The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.



The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinks. In a high-voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

Practical resistors have a series inductance and a small parallel capacitance; these specifications can be important in high-frequency applications. In a low-noise amplifier or pre-amp, the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology.

A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and the position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

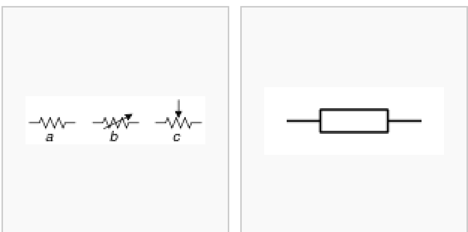
Units

The ohm (symbol: Ω) is the SI unit of electrical resistance, named after Georg Simon Ohm. An ohm is equivalent to a volt per ampere. Since resistors are specified and manufactured over a very large range of values, the derived units of milliohm (1 mΩ = 10−3 Ω), kilohm (1 kΩ = 103 Ω), and megohm (1 MΩ = 106 Ω) are also in common usage.

The reciprocal of resistance R is called conductance G = 1/R and is measured in siemens (SI unit), sometimes referred to as a mho. Hence, siemens is the reciprocal of an ohm; $S = \Omega^{-1}$. Although the concept of conductance is often used in circuit analysis, practical resistors are always specified in terms of their resistance (ohms) rather than conductance.

Electronic Symbols and Notation

The symbol used for a resistor in a circuit diagram varies from standard to standard and country to country. Two typical symbols are as follows;



American-style symbols. (a) resistor, (b) rheostat (variable resistor), and (c) potentiometer

IEC-style resistor symbol

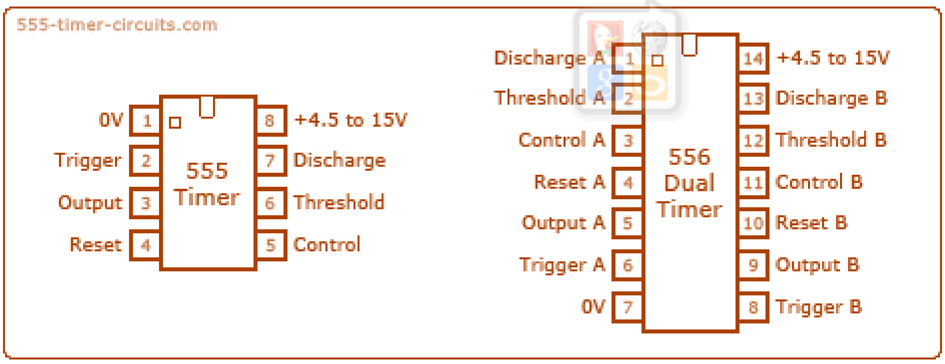
The notation to state a resistor's value in a circuit diagram varies, too. The European notation avoids using a decimal separator, and replaces the decimal separator with the SI prefix symbol for the particular value.

For example, 8k2 in a circuit diagram indicates a resistor value of 8.2 kΩ. Additional zeros imply tighter tolerance, for example 15M0. When the value can be expressed without the need for an SI prefix, an 'R' is used instead of the decimal separator. For example, 1R2 indicates 1.2 Ω, and 18R indicates 18 Ω. The use of a SI prefix symbol or the letter 'R' circumvents the problem that decimal separators tend to 'disappear' when photocopying a printed circuit diagram.

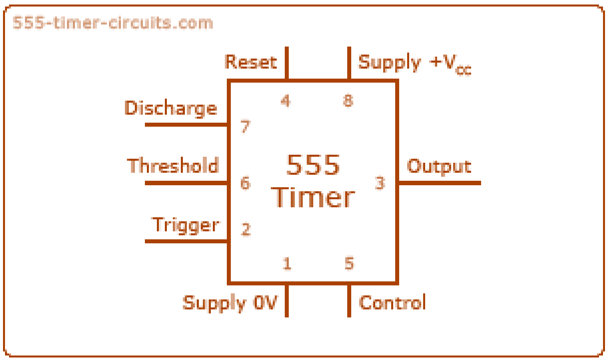
An Overview of the 555 Timer

The 555 Integrated Circuit (IC) is an easy to use timer that has many applications. It is widely used in electronic circuits and this popularity means it is also very cheap to purchase, typically costing around 30p. A 'dual' version called the 556 is also available which includes two independent 555 ICs in one package.

The following illustration shows both the 555 (8-pin) and the 556 (14-pin).



In a circuit diagram the 555 timer chip is often drawn like the illustration below. Notice how the pins are not in the same order as the actual chip, this is because it is much easier to recognize the function of each pin, and makes drawing circuit diagrams much easier.

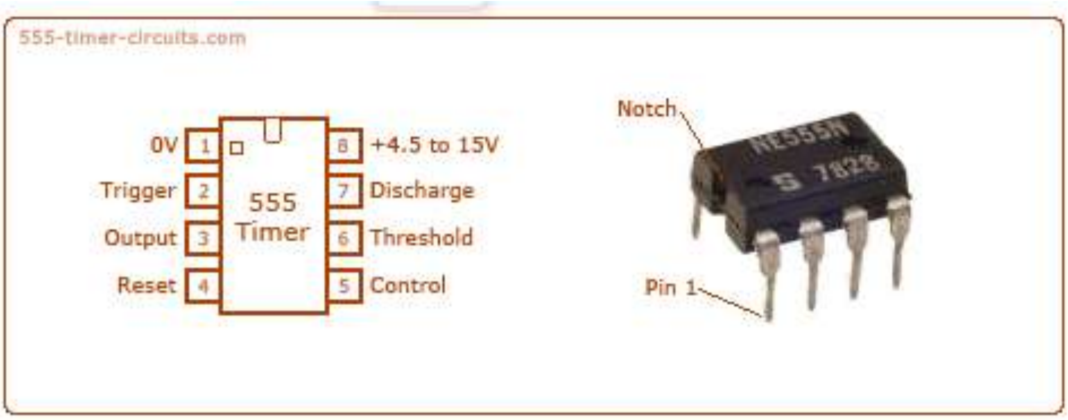


For the 555 to function it relies on both analogue and digital electronic techniques, but if we consider its output only, it can be thought of as a digital device. The output can be in one of two states at any time, the first state is the 'low' state, which is 0v.

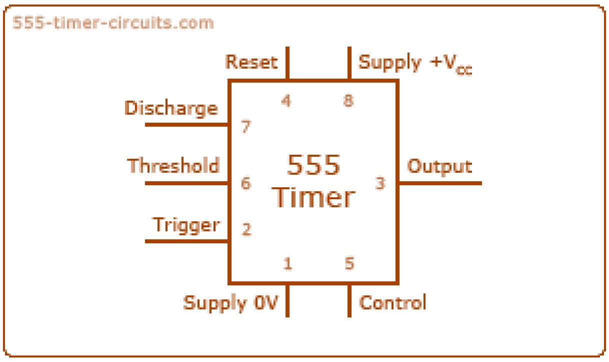
The second state is the high' state, which is the voltage Vs (The voltage of your power supply which can be anything from 4.5 to 15v. 18v absolute maximum). The most common types of outputs can be categorized by the following (their names give you a clue as to their functions):

- Monostable mode: in this mode, the 555 functions as a "one-shot". Applications include timers, missing pulse detection, bouncefree switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) etc
- Astable - free running mode: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation, etc.
- Bistable mode or Schmitt trigger: the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bouncefree latched switches, etc.

Pin Configuration of the 555 Timer



When drawing a circuit diagram, always draw the 555 as a building block, as shown below with the pins in the following locations. This will help you instantly recognise the function of each pin:



Pin 1 (Ground):

Connects to the 0v power supply.

Pin 2 (Trigger):

Detects 1/3 of rail voltage to make output HIGH. Pin 2 has control over pin 6. If pin 2 is LOW, and pin 6 LOW, output goes and stays HIGH. If pin 6 HIGH, and pin 2 goes LOW, output goes LOW while pin 2 LOW. This pin has a very high impedance (about 10M) and will trigger with about 1uA.

Pin 3 (Output):
(Pins 3 and 7 are "in phase.") Goes HIGH (about 2v less than rail) and LOW (about 0.5v less than 0v) and will deliver up to 200mA.

Pin 4 (Reset):
Internally connected HIGH via 100k. Must be taken below 0.8v to reset the chip.

Pin 5 (Control):
A voltage applied to this pin will vary the timing of the RC network (quite considerably).

Pin 6 (Threshold):
Detects 2/3 of rail voltage to make output LOW only if pin 2 is HIGH. This pin has a very high impedance (about 10M) and will trigger with about 0.2uA.

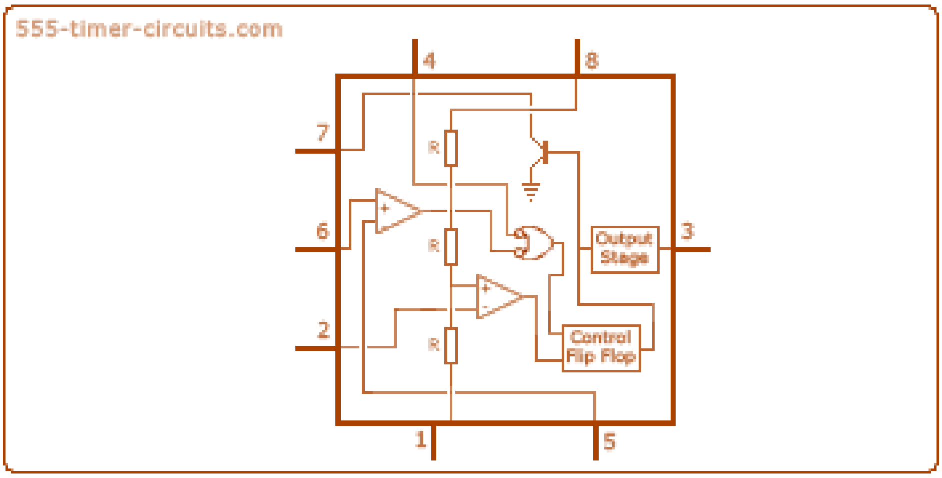
Pin 7 (Discharge):

Goes LOW when pin 6 detects 2/3 rail voltage but pin 2 must be HIGH. If pin 2 is HIGH, pin 6 can be HIGH or LOW and pin 7 remains LOW. Goes OPEN (HIGH) and stays HIGH when pin 2 detects 1/3 rail voltage (even as a LOW pulse) when pin 6 is LOW. (Pins 7 and 3 are "in phase.") Pin 7 is equal to pin 3 but pin 7 does not go high - it goes OPEN. But it goes LOW and will sink about 200mA.

Pin 8 (Supply):
Connects to the positive power supply (Vs). This can be any voltage between 4.5V and 15V DC, but is commonly 5V DC when working with digital ICs.

Inside the 555 Timer

You may wonder what is inside the 555 timer chip or what makes it work. Well, the 555 timer chip an Intergrated Circuit (IC) and therefore it contains a miniturized circuit surrounded by silicon. Each of the pins is connected to the circuit which consists of over 20 transistors, 2 diodes and 15 resistors.

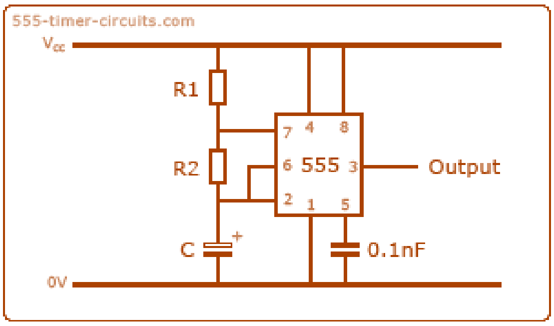


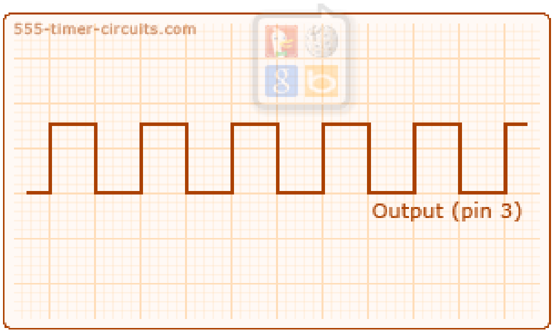
555 Timer Operating Modes

The 555 has three main operating modes, Monostable, Astable, and Bistable. Each mode represents a different type of circuit that has a particular output.

Astable Mode

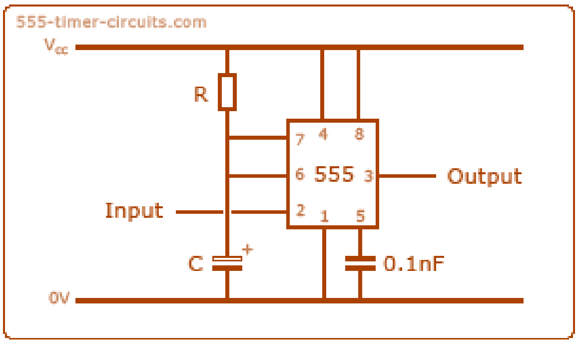
An Astable Circuit has no stable state - hence the name "astable". The output continually switches state between high and low without without any intervention from the user, called a 'square' wave. This type of circuit could be used to give a mechanism intermittent motion by switching a motor on and off at regular intervals. It can also be used to flash lamps and LEDs, and is useful as a 'clock' pulse for other digital ICs and circuits.

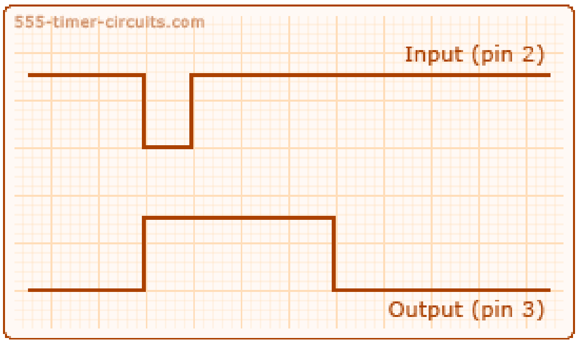




Monostable mode

A Monostable Circuit produces one pulse of a set length in response to a trigger input such as a push button. The output of the circuit stays in the low state until there is a trigger input, hence the name "monostable" meaning "singlestable state". This type of circuit is ideal for use in a "push to operate" system for a model displayed at exhibitions. A visitor can push a button to start a model's mechanism to work, and the mechanism will automatically switch off after a set time.

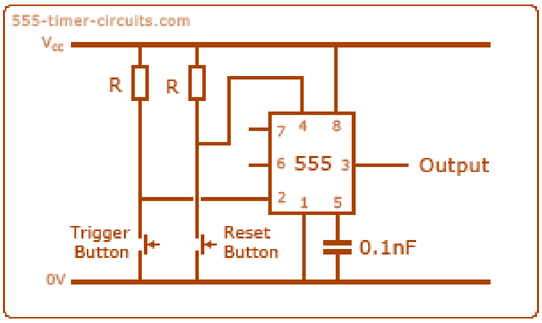


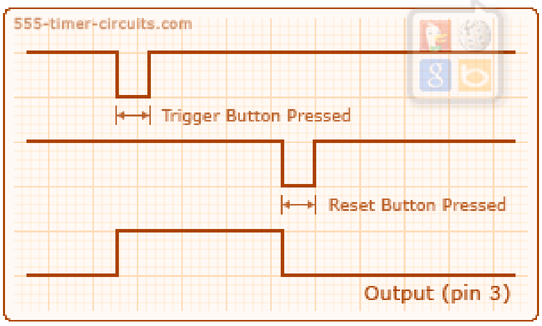


Bistable Mode (or Schmitt Trigger)

A Bistable Mode or what is sometimes called a Schmitt Trigger, has two stable states, high and low. Taking the Trigger input low makes the output of the circuit go into the high state. Taking the Reset input low makes the output of the circuit go into the low state. This type of circuit is ideal for use in an automated model railway system where the train is required to run back and forth over the same piece of track.

A push button (or reed switch with a magnet on the underside of the train) would be placed at each end of the track so that when one is hit by the train, it will either trigger or reset the bistable. The output of the 555 would control a DPDT relay which would be wired as a reversing switch to reverse the direction of current to the track, thereby reversing the direction of the train.





Using the Output of a 555 Timer

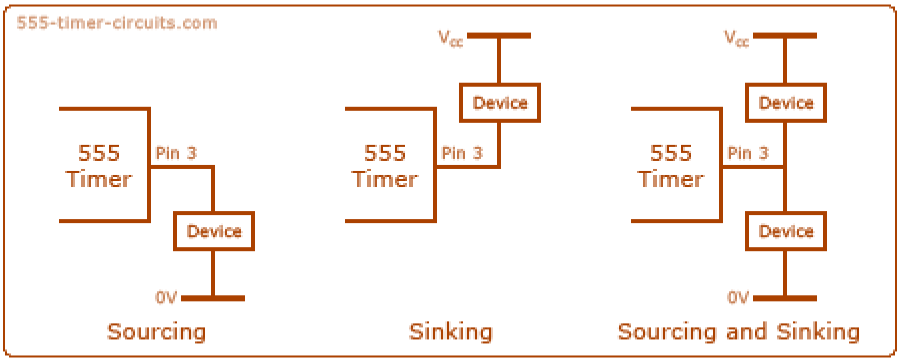
The output (Pin 3) of the 555 can be in one of two states at any time, which means it is a digital output. It can be connected directly to the inputs of other digital ICs, or it can control other devices with the help of a few extra components. The first state is the 'low' state, which is the voltage 0V at the power supply. The second state is the 'high' state, which is the voltage Vcc at the power supply.

Sinking and Sourcing

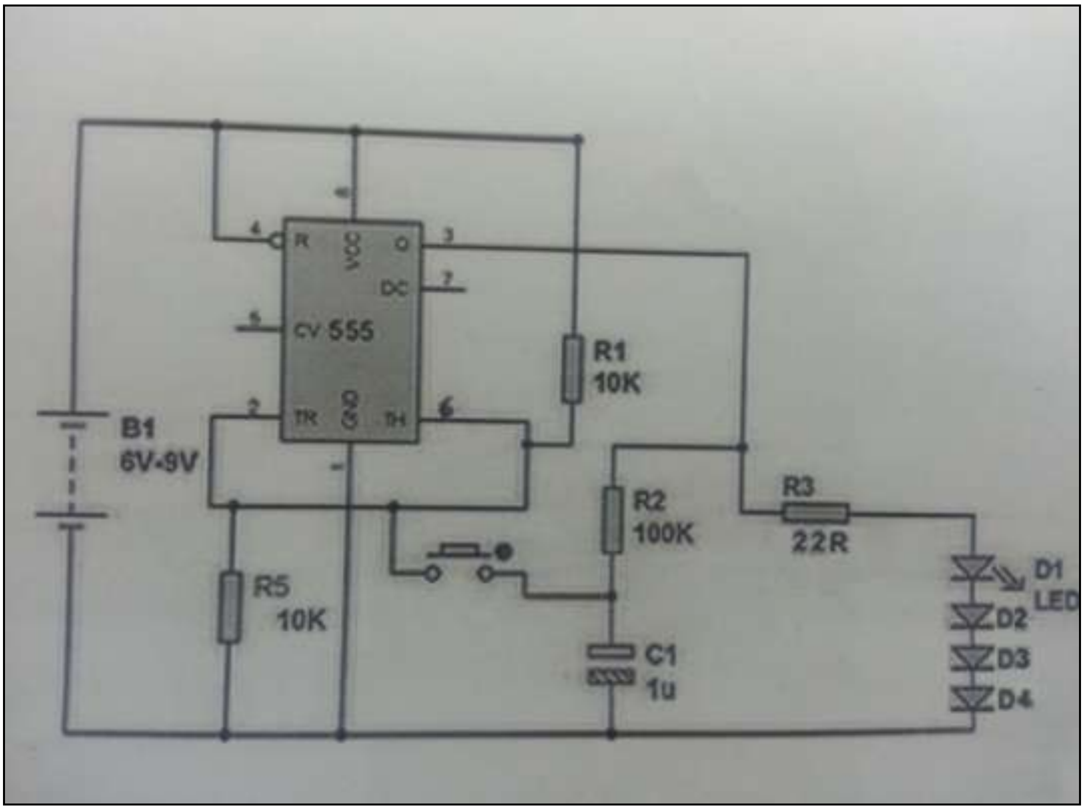
When the Output goes low, current will flow through the device and switch it on. This is called 'sinking' current because the current is sourced from Vs and flows through the device and the 555 to 0V.

When the Output goes high, current will flow through the device and switch it on. This is called 'sourcing' current because the current is sourced from the 555 and flows through the device to 0V.

Sinking and sourcing can also be used together so that two devices can be alternately switched on and off.



The device(s) could be anything that can be switched on and off, such as LEDs, lamps, relays, motors or electromagnets. Unfortunately, these devices have to be connected to the Output in different ways because the Output of the 555 can only source or sink a current of up to 200mA. Make sure your power supply can provide enough current for both the device and the 555, otherwise the timing of the 555 will be affected.

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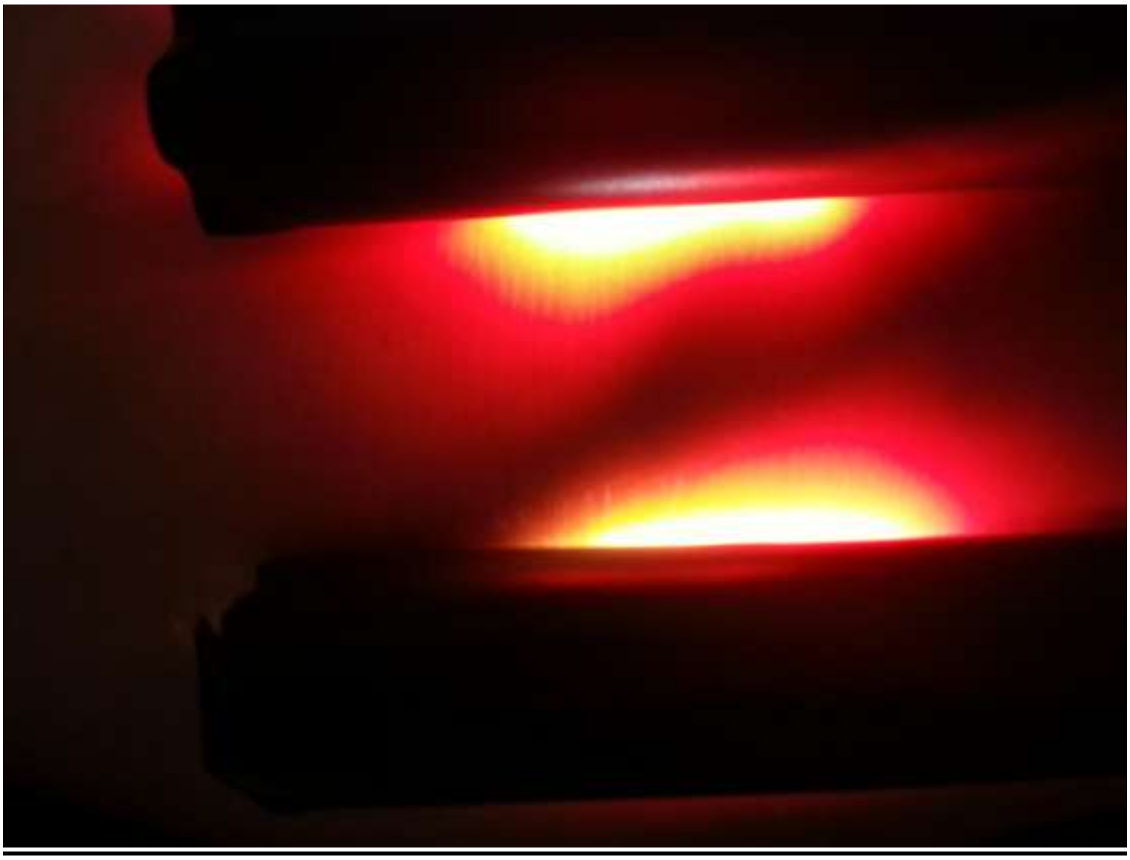

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