UNIT 3 PHYSIOLOGICAL VARIABLES

Introduction

Physiological anthropology is connected to physical anthropology and is concerned with the uniqueness that relate to biology. It focuses to elucidate human physiological features, in a wide sense. Seen in this viewpoint, physiological anthropology belongs to the basic natural sciences. It flourishes on living organisms that vary in many different ways. Living organisms, in the process of evolution, have differentiated in many different directions up to the current day. And within the same species, as individual specimens or in groups, they have come to have widely varying functional, morphological and behavioral characteristics which only physiological anthropology takes into account. The second different aspect of physiological anthropology is that the objects of study of physiological anthropology are we ourselves, human beings, who have unique physiological functions compared to other animals in nature. In short, this refers to very highly developed mental abilities and it is impossible when studying human beings in a comprehensive way to overlook the existence of these distinctive abilities. Physiological anthropology is an area focused on the understanding of human nature and behavior in reference to their environment based on physiological mechanisms. These biological roles which are based on behavioral physiological mechanisms have a constructive effect for the living being resulting as being a form of "adaptation".

Some adaptations might lead to frequent complaints pertaining to body problems, basically physiological in nature such as low or high blood pressure, obesity etc. Such problems have become very common. Blood pressure can be defined as the pressure exerted by blood on the arterial wall. What happens is that with each ventricular beat i. e. when left ventricle contracts, blood enter the aorta which is already filled with blood. As more and more blood enters the aorta, the blood flow exerts pressure on the elastic arterial wall. This pressure is called 'blood pressure'. Most people have had their blood pressure checked at some point of time, either due to curiosity or on a visit to clinician for some discomfort, isn't it? You must have seen that it is simple and quite painless procedure, yet gives vital information about our heart and the condition of the blood vessels.

Now, what is measured while taking blood pressure? Well it is the maximum pressure (systolic) and the lowest pressure (diastolic) made by the beating of the heart that is measured. The question what is the maximum or systolic pressure and what is the minimum or diastolic pressure. The systolic pressure is the maximum pressure in an artery at the moment when the heart is beating and pumping blood through the body. The diastolic pressure is the lowest pressure in an artery in the moments between beats when the heart is resting. Both the systolic and diastolic pressure measurements are important – if either one is raised i.e., more than the standard value one is said to have high blood pressure or hypertension. How do you measure the blood pressure? Sphygmomanometer is the answer.

Sphygmomanometer

A sphygmomanometer or blood pressure meter is a tool used to measure blood pressure particularly in arteries, made up of an inflatable cuff, the function of

which is to restrict blood flow, and a mercury or mechanical manometer to measure the pressure. The fundamental behind it is that it is always used to record reading at the time when blood pressure flow has just started and at what pressure it is unimpeded. Stethoscope is prerequisite while using manual sphygmomanometers.

The word sphygmomanometer comprises of two Greek words 'sphygmós' meaning the beating of the heart or the pulse and a scientific word manometer refers to device for measuring pressure or tension. The credit of inventing sphygmomanometer goes to Samuel Siegfried Karl Ritter von Basch in 1881, although it was Scipione Riva-Rocci, an Italian physician who introduced a more easily used version in 1896. However, popularity of this device increased only in 1901 after being discovered by Harvey Cushing. Joseph Erlanger (1874-1965), an American physiologist studied the principles of sphygmomanometry and devised a recording sphygmomanometer. There are two types of manual sphygmomanometers available; one with a mercury column and a gauge with a dial face, but the sphygmomanometer which is most frequently used today consists of a mercury manometer serving as a measuring unit and inflation bulb and valve i.e., a gauge is attached to a rubber cuff wrapped around the upper arm and is inflated to constrict the arteries.

There are three versions of sphygmomanometers available:

Manual sphygmomanometers: Manual sphygmomanometers are most ideal and conventional device to measure the blood pressure; as they are unfailingly accurate. Since their reliability quotient is very high they are ideal for monitoring blood pressure for high risk patient and also pregnant women. The unit of measurement of blood pressure is millimeters of mercury (mmHg) and is usually calibrated in an even number. Stethoscope usage is mandatory incase of manual sphygmomanometers auscultation (listening to sounds within the body using a stethoscope), because only systolic blood pressure is recorded through palpation.

Clinical Mercury Manometer

Source: 1

Digital with manual or automatic inflation: This is an electronic device, easy to manage, and functional in noisy environments. It works on the principle of measuring mean arterial pressure [Mean arterial pressure (MAP) is a term used in medicine to describe an average blood pressure in an individual during a single cardiac cycle] and use oscillometric detection to calculate systolic and diastolic values. This is an indirect way to measure the blood pressure, since it derives the readings. Digital oscillometric monitors have their own limitations as they cannot be used in certain conditions like arteriosclerosis, arrhythmia, preeclampsia, pulsus alternans and pulsus paradoxus.

Digital portable sphygmomanometers: These sphygmomanometers are portable hence easier to operate but are comparatively less accurate.

Source: www.wikimedia.org

Wrist cuff blood pressure monitors are also in use but are found to be quite erroneous, and the monitor has to be at the level of the heart when recording the reading. These are the smallest blood pressure monitors, and are finger blood pressure monitors having automatic inflation.

Source: u17052091 fotosearch.com

Stethoscope

The term stethoscope is derived from Greek word 'stéthos' which means chest and 'skopé' meaning examination. It is an acoustic medical device used in medical application for audio purposes for auscultation, i.e., listening to the internal sounds of the body. Its application comprises listening to lung, heart sounds, intestines and blood flow in arteries and veins. When in combination with a sphymomanometer, it is commonly used in measuring the blood pressure. You would be surprised to know that "mechanic's stethoscopes" are used to listen to internal sounds made by machines, such as diagnosing a malfunctioning automobile engine by listening to the sounds of its internal parts and also to check scientific vacuum chambers for leaks, and for various other small-scale acoustic monitoring tasks.

Source: www.lotusoverseas.com

Let's see how sphygmomanometer functions. First of all we must know that the sphygmomanometer measure two readings of blood pressure: systolic and diastolic blood pressure. Systolic blood pressure refers to systole; this is the phase when the heart pumps blood out into the aorta or we can say it the measure of pressure exerted by the blood on the wall of the vessel during each contraction of the ventricular muscle and diastolic blood pressure refers to diastole, the resting period when the heart refills with blood as blood fills up the aorta, the pressure which remains in the arteries during the relaxation of the heart. It means that with each heartbeat, blood pressure is raised to the systolic level, and between beats, it drops to the diastolic level. The blood pressure is measured in 'mmHg' units by observing the mercury in the column when the air pressure is released using a control valve. The peak pressure or the maximum pressure in the arteries during the cardiac cycle is the systolic pressure, and the lowest pressure that is at the resting phase of the cardiac cycle is termed as diastolic pressure. Systolic

pressure (first phase) is identified with the starting or first of the continuous Korotkoff sounds whereas the diastolic pressure is identified at that moment when the Korotkoff sounds disappear (fifth phase). A stethoscope is used in the auscultatory method.

The question arises, how do you measure the blood pressure?

To start with the subject has to be in relaxed comfortably seated position with arms well supported. It can also be taken while lying down, and then it is called in supine position. Always remember that blood pressure is measured by inflating a cuff around the arm. Tie the cuff around the upper arm of the subject and keep it in place using Velcro. The cuff is generally tied smoothly and snugly around an upper arm, at the same height as the heart when the subject is seated with the arm supported. There is a tube attached to the cuff which connects the rubber bulb. The cuff is inflated till the artery is completely occluded. When the cuff is inflated with air, a stethoscope is placed over the brachial artery in the crook of the arm. When the pressure in the cuffs falls, a "whooshing" or pounding sound is heard called as Korotkoff sounds, this is the situation when blood flow first starts again in the artery. The moment the air in the cuff is released, the very first sound audible through the stethoscope symbolizes the systolic pressure. As the release of air from the cuff continues there comes a point when the sound diminishes and then one can no longer hear it. The point where the sound disappears is considered to be the diastolic pressure. Thus, the blood pressure reading recorded represents the systolic and diastolic pressures. When we say that blood pressure is 120/80 then means 120 and 80 mm of mercury (Hg) respectively with 120 denoting systolic blood pressure and 80 denoting diastolic blood pressure. A typical blood pressure said to be normal for an adult is 120/78. This reading varies with age and influenced by many other factors.

The seventh report of Joint National Committee in 2004 on prevention, detection, evaluation and treatment of blood pressure has given the following standards for blood pressure:

Category	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Normal	< 120	< 80
Pre-hypertensive	120-139	80-89
Hypertensive	> 140	> 90

Measuring Blood Pressure

Source: pe0062147 fotosearch.com

Source: bld061575 fotosearch.com

Source: k0415478 www.fotosearch.com

These days' electronic measuring devices are commonly found to be used by people at their home to measure blood pressure (since mercury is being phased out because of its hazardous nature). They are found to be accurate enough for routine clinical use, more users friendly and are relatively inexpensive. The chances of errors in blood pressure measurement that human beings can generate are reduced.

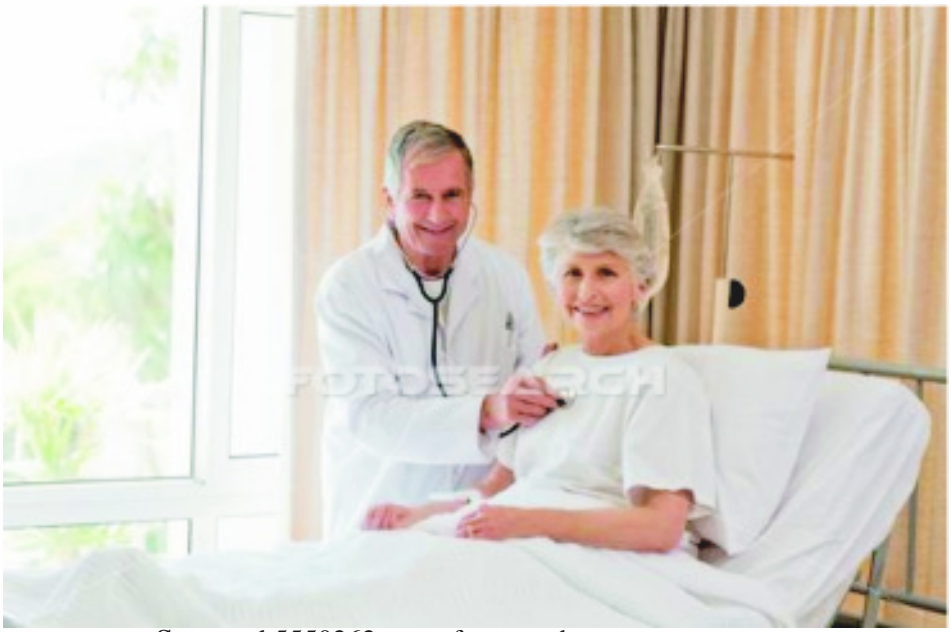
Ambulatory blood pressure monitoring (ABPM) entails measuring the blood pressure for 24 hours during the daily routine and even during sleep. In this, the

device measures the blood pressure at regular intervals. The readings are recorded on a chip in the device and give a detailed picture of blood pressure variation in a normal environment. Ambulatory blood pressure monitoring is advised when high blood pressure is resistant, that is no reaction to drug treatment – three or more drugs or help in the identification of high blood pressure related to anxiety in the clinical setting, known as 'white coat hypertension' or when the blood pressure is showing atypical variation or probably when symptoms suggest the possibility of low blood pressure due to over-treatment.

Measuring Heart Rate

If you know how to measure your heart rate or pulse, it facilitates in learning about your own level of fitness and detect potential medical problems that should be brought to the attention of your physician incase of an irregular reading. What is Heart Rate? As the name suggests it is number of times heart beats in a minute measured by feeling your pulse. It is the rhythmic expansion and contraction (or throbbing) of an artery as blood is forced through it by the regular contractions of the heart. It is a measure of how hard your heart is working by feeling the pulse.

Source: px265058 www.fotosearch.com



Source: k5550262 www.fotosearch.com

Heart rate is defined as the number of ventricular beats per minute. The heart rate can be recorded at any point on the body at which an artery is close to the surface and a palpitation can be experienced. The most common places to measure heart rate using the palpation method is at the wrist (radial artery) and the neck (carotid artery). Elbow (brachial artery) and the groin (femoral artery) are also sometimes used. Always remember to use your fingers to take a pulse, not your thumb. This is particularly when recording someone else's pulse, because sometimes you feel your own pulse through your thumb. How do you record the heart rate?

Manual Method

Carotid Pulse (neck) – In this case when heart rate is taken at the neck, the first two fingers on either side of the neck are positioned, and the number of beats for a minute is then counted.

Radial Pulse (wrist) – Radial pulse rate involves index and middle fingers together to be placed on the opposite wrist, about $^1/_2$ inch on the inside of the joint, in line with the index finger. As soon as pulse is felt, number of beats felt within a one minute period is counted.

Monitor Method

A heart rate monitor is often used to get a more precise heart rate measurement. This holds significance particularly during exercise where the motion of exercise often makes it hard to get a clear measurement using the manual method. This heart rate monitor is especially useful when recording heart rate changes over short time periods. At times heart rate monitors require a little body sweat between the chest strap and the skin for best conduction of the signal. In such cases, care should be taken that there is a good connection between the chest strap and the chest, and some water or other fluid can be added to enhance the conductivity too.

Source:www.chicagonow.com

Let us understand what is a normal heart rate? Well, a resting heart rate anywhere in the range of 60 - 90 is counted in the normal range. It fluctuates a lot depending on factors like activity level and stress level. Nevertheless if beat is consistently above 90, it needs medical attention. This condition of high heart rate is termed as tachycardia (increased heart rate). It has been observed that in many athletes the pulse rate is in the range of 40 - 60 depending upon their fitness level. However, a lower pulse rate is considered to be good. But if the heart rate is too low, it is termed as bradycardia and can be a dangerous situation combined together with low blood pressure. A person would feel weakness, loss of energy and fainting. It warrants for medical attention.

There can be situation when the pattern of beats are irregular (i. e. a beat is missed) on a consistent basis, such cases necessitate medical attention. There are many factors that influence heart rate like emotions, climatic temperatures, posture (sitting, standing, lying down), and body size (if the person is overweight for size, the heart will have to work harder to supply energy to your body). It is always good to experience a decrease in resting heart rate as one of the benefits of increased fitness due to exercise. This is because heart is a muscle and will respond just like any skeletal muscle in that it will become stronger through conditioning. If the heart muscles are stronger, then heart rate will decrease. In fact, heart will be putting out less effort to pump the same amount of blood.

What should be your heart rate? Are you not curious to know?

Take 220 and subtract your age. For example, if you are 36 years old, subtract 36 from 220 (220 - 36= 184). This means that your maximum physiological limit as to how fast your heart should beat is 184 beats per minute. Now see what should be yours.

Pulse rate

Your pulse can be felt at the wrist, neck, groin or top of the foot - areas where the artery is close to the skin. Most commonly, people measure their pulse in their wrist. This is called the radial pulse. How to measure your Pulse?

The first time that you try to take your pulse it may be a little difficult proposition. Place the index and middle fingers of your right hand on the thumb side of your left wrist until you feel your pulse throbbing under your fingers. Using the second hand on your watch starting the first beat at zero, count how many times your pulse beats in fifteen seconds.

Source: k0699955 www.fotosearch.com

Haemoglobin estimation

Haemoglobin is a protein used by red blood cells to distribute oxygen further to other tissues and cells in the body. It constitutes of heme, which comprises iron atoms plus the red pigment, porphyrin, (responsible for giving the blood its red colour) and globin a chain of amino acids. Haemoglobin, which is a complex protein-iron compound in the blood has an important function to carry oxygen to the cells from the lungs and carbon dioxide away from the cells to the lungs. Each erythrocyte contains about 200 to 300 molecules of hemoglobin, and then every molecule of hemoglobin consist of four groups of heme, and each group of heme has potential carry one molecule of oxygen. Hemoglobin molecule comprises four globin polypeptide chains composed of amino acids, with each polypeptide chain composed of 141 to 146 amino acids. The absence, replacement, or addition of only one amino acid alters the characteristics of the hemoglobin. Different kinds of hemoglobin are recognized by their specific arrangement of polypeptide chains. Mostly alpha and beta chains are found with gamma and delta being found less often. When there is an atmosphere of high oxygen concentration, such as in the lungs, hemoglobin has the characteristics to the bind with oxygen to form oxyhemoglobin and in an atmosphere of low oxygen concentration, such as in the peripheral tissues of the body, oxygen is substituted by carbondioxide to form carboxyhemoglobin. Hemoglobin releases the carboxyhemoglobin in the lungs for excretion and picks up more oxygen for transport to the cells. The normal concentrations of hemoglobin in the blood are 12 to 16 g/dL (grams per deciliter) in women and 13.5 to 18 g/dL in men.

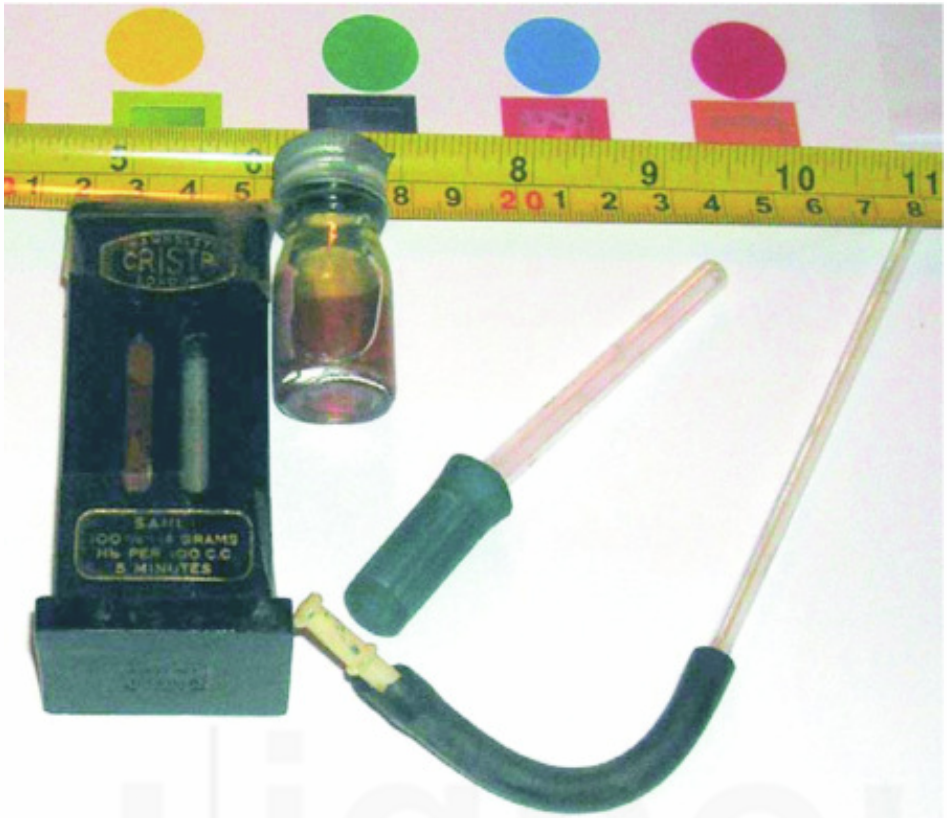
Hemoglobin estimation

A determination of the hemoglobin content of the blood is called Hemoglobin estimation. The test measures the amount of this substance in a specific volume of blood. It also indicates the amount of intracellular iron. Being an important indicator of anemia, hemoglobin estimation is also used in blood transfusions.

Methods of estimation

One of the basic techniques for estimating hemoglobin calorimetrically, is with a haemometer.

The Sahli haemometer method utilises the conversion of haemoglobin into acid haematin which has a brown colour in solution. The principle of the instrument is that Haemoglobin present in a sample of blood is changed into acid hematin by adding N/l0 HCl to the blood and its haemoglobin content is ascertained by matching the solution against non fading glass having a standard colour. The intensity of the colour is associated to the quantity of haemoglobin in the blood sample. The purpose of adding water is to dilute the brown solution until it matches that of a standard. The more haemoglobin, the more water required to arrive at the matching colour. Haemoglobin values are recorded at the meniscus of the brown solution.



Source:www.health.adelaide.edu

Sahli's Haemoglobinometer consists of:

- Comparator box possess
- Special diluting tube
- Haemoglobin pipette
- Glass stirrer
- A bottle containing Nil OHCL

Standards for estimation

Normal range Varies with altitude.

Male - 8.1 to 11.2 mmol/L (13 to 18 gm/dL)

Female - 7.4 to 9.9 mmol/L (12 to 16 gm/dL)

Child - 7.1 to 8.4 mmol/L (11.5 to 13.5 gm/dL)

Newborns - 10.5 to 13.7 mmol/L (17 to 22 gm/dl)

PRACTICE 1

Record the blood pressure of eight subjects.

Introduction

Blood pressure can be defined as the pressure exerted by blood on the arterial wall when blood enters the aorta already filled with blood. As more and more blood enters the aorta, the blood flow exerts pressure on the elastic arterial wall. This pressure is called the blood pressure. The systolic pressure is defined as the maximum pressure in an artery at the moment when the heart is beating and pumping blood through the body. The diastolic pressure is considered to be the lowest pressure in an artery in the moments between beats when the heart is resting. Both the systolic and diastolic pressure measurements hold significance clinically.

Instruments used

Sphygmomanometer, stethoscope

Procedure and Instructions

To start with deflate the bladder of the cuff. Ask the subject to sit in a relaxed position on a chair with the arms supported comfortably at the level of fourth intercostal space and facing forward. Wrap the cuff around the upper arm to fit it snugly, but not too tightly about an inch above the elbow at chest level using the Velcro. Hold the bulb/pump with your palm in such a manner that your fingers can easily reach the valve at the top to open/close the outlet to the air bladder wrapped around the person's arm. A tube leads out of the cuff to a rubber bulb and another one from cuff to the vertical glass column which has stored mercury in it. The mercury is housed within a sealed system in such a manner that only air travels in the rubber tubing and the cuff. This mercury column is very important as this is the place where the blood pressure is recorded.

Now place chest piece of the stethoscope lightly over the brachial artery above the crease of the elbow of your subject just under the edge of the cuff. The stethoscope should ideally be placed lightly over the brachial artery, since the use of excessive pressure can increase turbulence and delay the disappearance of sound. Use your right hand and hold it firmly there and the ear piece into your ears. Pump in the air through the bulb by squeezing and inflate the cuff by so that there is increased pressure and the subject feels tightening on the upper arm. Slowly open the valve on the air pump slightly, now this comes really with practice as it is neither recommended to let the air out suddenly nor too slowly as it difficult for fingers to maneuver. Be very careful while listening to the pulse when you let out the air slowly. The systolic pressure is measured when you first hear the pulse. Now as the needle on the pressure gauge starts falling you can hear a slight "blrrpp" or a something that sounds like "prrpshh.". Note down the reading when you hear it for the first time. This is systolic blood pressure. This sound continues and becomes louder with increasing intensity. Slowly this sound would become more distant and finally disappear. The reading, after which the sound of the pulse disappears, is called as diastolic blood pressure. Always remember that the blood pressure is measured in terms of millimeters of mercury (mmHg). After you have recorded the blood pressure open the valve so as to completely remove the remaining air from the bulb. It takes practice to take the

blood pressure accurately, you must get accustomed to the sound of pulse appearing and disappearing.

Precautions

Prior to initiating the practical explain to your subject the procedure and objective behind taking the blood pressure.

Check if sphygmomanometer is in functional condition.

The subject should be in a relaxed position throughout the whole process.

Blood pressure should not be taken if the subject has eaten at least half an hour prior to being measured.

Do not take blood pressure immediately after the subject has performed any physical activity.

Practice 1

Subjects	**Systolic blood pressure (mmHg)**	**Diastolic blood pressure (mmHg)**
1		
2		
3		
4		
5		
6		
7		
8		

PRACTICE 2

Record the heart rate and pulse rate of eight subjects.

Heart Rate

Heart rate is the number of heartbeats per unit of time, conventionally expressed as *beats per minute* (bpm). Variation in heart rate has been observed depending upon the body's need to absorb oxygen and excrete carbondioxide changes, like during exercise or sleep. Heart rate gives vital information on diagnosis and tracking of medical conditions. Apart from medical concerns it is used by athletes, in monitoring their heart rate to gain maximum efficiency from their training.

Instruments used

Stethoscope and stop watch.

Procedure and Instructions

Ask the subject to sit in a relaxed position on a chair. Place the chest piece of the stethoscope on the left side of the chest of the subject. It should be just below the nipple or wherever the heartbeat is strongly felt. Count the beats for one minute using a stop watch and the note down the reading.

Precautions

- The subject should be made comfortable and seated in a relaxed sitting position.
- The subject should not have exerted like exercise or brisk walking before the measurement is taken.
- The measurement should not be taken at least half an hour after the meals.

Pulse Rate

Pulse rate is the frequency of pressure waves (waves per minute) transmit along the peripheral arteries such as carotid, brachial or radial arteries. The left ventricle pushes blood into the already blood filled aorta whose walls stretches with each contraction, to facilitate the flow of the blood to different parts of the body. The expansion of arteries starts at the root of aorta and proceeds as a wave along the whole arterial system. The wave of expansion is measured as pulse rate.

Instrument used

Stop watch.

Procedure and Instructions

Ask the subject to sit in a relaxed sitting position. Turn the palm side of your subject facing up. Now, place your index and middle fingers of your opposite hand on your wrist, approximately 1 inch below the base of your hand, that is towards the thumb side of the subject's right hand (radial artery) and feel the pulse point where your three fingers are placed. Press your fingers down in the grove between your middle tendons and your outside bone. You should feel a throbbing - the pulse. Record the number of pulse by counting it for a minute using stop watch.

Precautions

The subject should be sitting in a relaxed sitting position during the measurement.

The subject should not have exercised or eaten half an hour prior to the measurement.

Practice 2

Subjects	Heart rate (bpm)	Pulse rate (ppm)
1		
2		
3		
4		
5		
6		
7		
8		

Suggested Reading

The list is given at the end of unit 4.

PRACTICE 3

Estimate hemoglobin for eight subjects.

Hemoglobin Estimation

Hemoglobin estimation is a determination of the hemoglobin content of the blood. The RBC protein hemoglobin is incharge for oxygen transport. It is perhaps the most precise way of measuring the oxygen-carrying capacity of the blood is to determine its hemoglobin content. Oxygen, which unites reversibly with the heme (iron-containing portion) of the hemoglobin molecule, is singled out by the blood cells in the lungs and delivered in the tissues. Consequently the more hemoglobin molecules the RBCs contain, the more oxygen they will be able to transport. The standard normal blood contains 12 to 16 g hemoglobin per 100 mL blood. Hemoglobin content in men is (l4 to 18 g) whereas in women it is 12 to 16 g. There are number of techniques developed to estimate the hemoglobin content of blood, ranging from the old Sahli method to expensive colourimeter methods, which are precisely calibrated and yield highly accurate results.

Instrument used

Sahli's haemoglobinometer (haemometer), distilled water, rectified spirit, cotton, lancet.

Procedure

Take 5 drops of 0.1 N HCI (Hydrochloric acid) up to the lowest mark in the diluting tube. Put the diluting tube in the space provided in the box. Rectified spirit is used to sterilize the fingertip. Prick the finger to get moderately large drop of blood. Use the pipette to suck the blood up to the 20 mm^3 mark without any air bubble. Cotton is used to wipe off any blood sticking to the tip and sides of the pipette. Transfer the blood immediately into the acid present in the diluting tube. Rinse the pipette two or three times with the acid and transfer into the diluting tube. For haemoglobin to convert to acid haematin mix and keep it undisturbed for 10 minutes. Then dilute the contents by adding distilled water drop by drop and take care to mix the contents after each drop with the stirrer, till the colour matches with the colour of the standard. Record the reading both in gram scale and percentage scale by noting the lower meniscus. Record the hemoglobin as gm/100 mL

Precautions

There should not be any air bubble or blood clot in the column of the pipette.

Graduations on the diluting tube should not interfere with colour matching.

The glass rod should be lifted up before colour matching and reading.

Wipe off the excess blood sticking to the sides and tip of the pipette.

Transfer the contents without delay into the diluting tube and record the time.

Take the reading without any delay because on keeping the colour will deepen.

Practice 3

Sl. No.	Subject/Sex/Age	Hb (gm/dL)
1		
2		
3		
4		
5		
6		
7		