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PRACTICAL LAB MANUAL

HUMANAN ANATOMY AND PHYSIOLOGY

B. Pharm 1st Year (IInd Semester)

Human Anatomy and Physiology *(Practical)*

Experiment - 1

Recording of Body Temperature

Aim: To demonstrate recording of body temperature. Requirement Clinical thermometer.

Principle: Body temperature is the degree of sensible heat or cold which represents the balance between production and loss of heat by the body Normal body temperature. The physical properties of water in blood help to maintain body temperature. Normally, body temperature in adult human is 37°C (Celsius) or 98.4°F (Fahrenheit) when measured orally. This temperature corresponds to the temperature of vital organs of body and is also called as 'core or inner temperature. The temperature on skin of body is called as surface temperature. The constant core temperature of body enables it to carry on various physiological processes required for normal functioning. Physiological measurement of temperature is one of the first tests observed in a person if he/she is not feeling well. This is done by using a clinical thermometer. The body temperature is commonly recorded on three body locations i.e. mouth, rectum and arm pit. When the person cannot hold the thermometer in mouth, then arm pit or rectal temperature is Mercury tube recorded. In general, armpit temperature also called as axillary temperature is 1°F less than oral temperature which in turn is 0.5°F to 1°F less than rectal temperature. An elevation in body temperature (99 to 105°F) or (37.2 to 40.5°C)] is called fever at pyrexia which is usually due to bacterial, viral or other microbial infections.

Procedure:

Set the lowest reading in the thermometer by holding the end opposite to the mercury bulb firmly and shaking it downwards carefully until it reads 95°F or less.

(a) Recording of Mouth Temperature:

1. Ask the subject to place the thermometer under the tongue, and close the mouth Instruct the subject to use the lips and not teeth to hold the thermometer tightly in
Place.
2. During this subject shall be instructed to breathe through the nose.
3. After 2 minutes carefully take out thermometer and record temperature.
4. Take three readings at the interval of 5 minutes and calculate the mean body
Temperature

(b) Recording of Arm Pit Temperature:

1. Ask the subject to place the thermometer in arm pit with arm placed against body
2. After 5 minutes take it out and note the temperature.
3. Take three readings at the interval of 5 minutes and calculate the mean body temperature

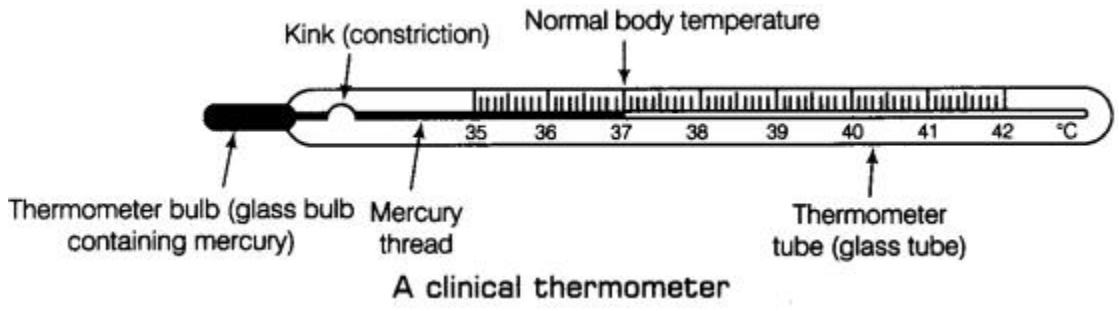

Fig 1: Clinical Thermometer

Observation:

Location	2nd Reading	3rd Reading	Mean
Mouth			
Arm pit			

Result: The mean body temperature recorded was-----

Experiment - 2

Recording of Basal Mass Index

Aim: To record basal mass index.

Requirements: Length measurement tape or height measurement chart and weighing balance.

Principle: Basal or Body Mass Index (BMI) is an internationally accepted measure of weight status of an individual. It is based on the differences in weights according to heights. BMI is calculated by dividing a person's weight in kilograms (kg) by the square of their height in metres (m) ie body weight (kg)/height (m). World Health Organisation (WHO) has classified category as undenveight: normal, overweight or obese based upon BMI values. Measurement of BMI is used as one of the diagnostic tests for overweight and obesity.

Procedure:

1. Select healthy human subject.
2. Ask the subject to stand in upright position with heels against the wall and without Wearing shoes / chappals / any footwear.
3 Measure the height in metres (1 feet = 0.3048 m; 1 inch = 0.0254 m).
4 Measure the weight in kg of the subject.
5. Calculate BMI using the following formula:

$$\textbf{BMI} = \textbf{Weight (Kg)} / \textbf{Height (m)}^2$$

Sl No	BMI	Category
1	<18.5	Underweight
2	18.5-24.9	Healthy normal acceptable weight
3	25.0-29.9	Grade 1 overweight
4	30.0-39.9	Grade 2 overweight
5	≥40	Grade 3 overweight

Observation Table:

Sl. No	Weight (kg)	Height (m)	BMI	Interpretation
-	-	-	-	-
-	-	-	-	-

Experiment- 3

Determination of Tidal Volume and Vital Capacity

Aim: To determine tidal volume and vital capacity.

Requirements: Spirometer; potassium permanganate solution.

Theory:
Spirometer consists of a double-walled metal cylindrical chamber, with a light metal gas bell of 6 liters capacity floating in an outer container filled with water. The water acts as an airtight seal. The bell is attached to a chain on its upper end which passes over a graduated frictionless pulley. The pulley has a spring-mounted indicator needle that indicates the volume of air present in the bell. The gas bell is counterbalanced by a weight attached to the other end of the chain for a smooth up and down movement of the bell. The inlet tube is corrugated canvas-rubber tube with a mouthpiece through which air moves into or out of the bell. This tube is attached to a metal pipe at the bottom of the spirometer. When air is blown into the inlet tube, it raises the bell in the container.

Vital Capacity (VC) is the largest volume of air that a person can expel from the lungs by forceful expiration after forceful inspiration. It can be measured using breath measuring device called spirometer (simple or recording). Simple spirometer is a low-cost and conventional instrument commonly used on the laboratory scale whereas recording spirometer is a sophisticated, electrically-driven instrument with recording system and widely used in respiratory physiology laboratories and hospitals.

The graphical recording of the spirometer is called a spirogram in which inspiration is recorded as an upward deflection and expiration as a downward deflection.

Calibrated pulley
The volume of air in lungs changes considerably during a respiratory cycle which can be distinguished as four different lung volumes:

1. **Tidal Volume (TV):** It is the amount of air that moves into the lungs with each inspiration (or the amount that moves out with each expiration) during normal breathing (tidal respiration). Normal TV is about 500 ml
2. **Inspiratory Reserve Volume (IRV):** It is the volume of additional inhaled air during deep breathing. It is about 3100 ml above the TV.
3. **Expiratory Reserve Volume (ERV):** It is the extra volume of exhaled air during forced expiration. It is about 1200 ml in addition to TV.

4. **Residual Volume (RV):** It is the volume of air remaining in the lungs after the expulsion ERV. It amounts to about 1200 ml. Combination of specific lung volumes gives lung capacities. The vital capacity (VC) is the total amount of air that can be exchanged between atmosphere and lungs during normal and forced respiration. It is calculated as:

Vital capacity (VC) (4800 ml) = IRV (3100 ml) + TV (500 ml) + ERV (1200 ml)

Normal vital capacity ranges between 3.5 and 6 liters. It is used clinically as an index of lung function and gives information about abnormal ventilation due to respiratory diseases.

Procedure:

1. Select one healthy subject for the demonstration.
2. Bring the bell to its lowest position by gently pushing it down. Adjust the pointer needle at zero, which indicates that the bell is completely empty.
3. Make the subject to stand comfortably, facing the spirometer to see the movement of bell.

Measurement of Vital Capacity:

1. After normal breathing for one minute, ask the subject to breathe as deeply and forcibly as possible to fill the lungs.
2. Ask him/her to close both the nostrils with a thumb and fingers, and hold the mouthpiece firmly between the lips.
3. In this position, ask to expel all the air with maximum effort into the spirometer. The bell moves up and the pointer on the pulley indicates the volume of expired air (The forced expiration should be deep and quick but without excessive speed).
4. Take two more readings at interval of 5 minutes.
5. Repeat this procedure in sitting position.

Measurement of Tidal Volume:

1. Ask the subject to breathe normally (quiet breathing) for the period of one minute.
2. Ask him/her to close both the nostrils with a thumb and fingers, and hold the mouthpiece firmly between the lips.
3. In this position, ask him/hers to expel the air with normal expiration. The bell moves up and the pointer on the pulley indicates the volume of expired.
4. Take two more readings at interval of 5 minutes.
5. Repeat this procedure in sitting position.

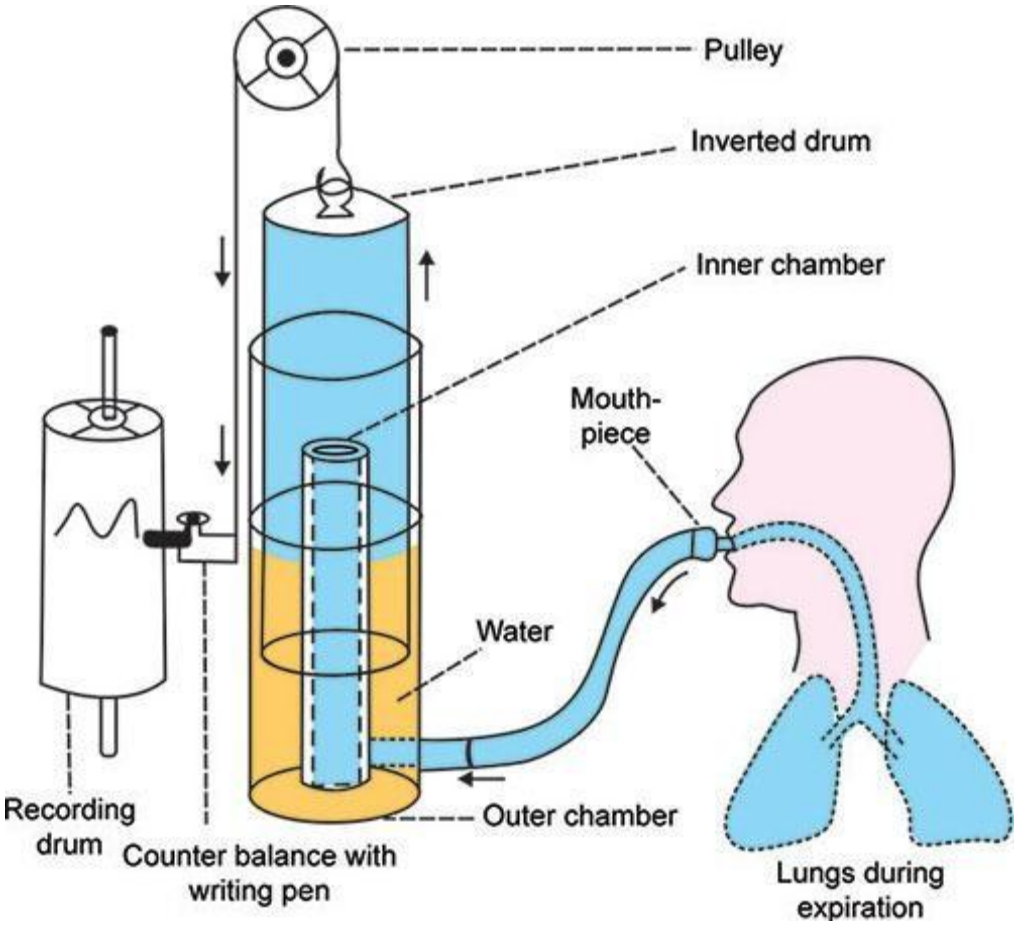

Fig 2: Simple Spirometer

Observation table:

Sl. No.	Parameters	Vital Capacity		Tidal volume	
		Standing	Sitting	Standing	Sitting
1	1st reading				
2	2nd reading				
3	3rd reading				
4	Mean				

Experiment- 4

Demonstration of the function of Olfactory Nerve

Aim: To demonstrate the function of Olfactory nerve.
Requirements: Clove oil turpentine oil alcohol peppermint oil eucalyptus oil etc.
Principle:
The olfactory nerve (I) is responsible for perception as well as adaptation of smell.
The perception of smell takes place by the pathway summarized below:

1. The olfactory receptors lie in the nasal epithelium in superior portion of nasal
2. The olfactory impulse is conducted through olfactory nerve to the olfactory bulb in which are activated by odorant stimuli.
3. The olfactory bulb neurons carry the impulse through olfactory tract to limbie system, thalamus and primary olfactory area of the temporal cortex which is perceived as smell.

Adaptation to smell is decreasing the sensitivity of the olfactory receptors. In general complete insensitivity to certain odours occurs within a minute after exposure to the odorant stimuli. It follows similar olfactory pathway as described above.
Procedure:
Select one healthy subject for the test.
(a) Perception of smell:
1 Ask the subject to close the eyes and then occlude one of the nostrils.
2. Ask the subject to smell and distinguish the odours of each of the test substances by each nostril separately.
3. Record the results as +/- for smell perception as per the observation table.
(b) Adaptation to smell:
1. Ask the subject to occlude one nostril and to smell the test substance 1 until the smell is no longer detected and the nostril gets adapted.
2. Immediately ask the subject to distinguish between smell of test substance 2 and 3 with the same adapted nostril.
3. Record the results as +/- for adaptation to smell as per the observation table.

Observation table:

Sl. No	**Test**	**Test Substances 1**	**Test Substances 2**	**Test Substances 3**
		Clove oil (-/+)	**Turpentine oil (-/+)**	**Alcohol (-/+)**
1	Perception of smell			
2	Adaptation to smell			

Experiment- 5

Examination of the Different Types of Taste

Aim: To examine the different types of taste.

Requirements: Sucrose solution (10%), sodium chloride solution (15%), acetic acid solution (1%), Ipecac solution (0.1%), dropper bottles, a hand lens, cotton swabs, four cards with sweet, salt, sour and bitter printed on them.

Principle:

The primary taste sensations include sweet, sour, salty and bitter. The taste (also called gustatory) receptors responsible for sensation of these tastes are located in taste buds of different regions of the tongue. The sweet taste is experienced near the tip of the tongue, salt on the sides and top, bitter in the posterior part, and sour sensation in between these
areas.

The perception of taste occurs through the pathway summarized below:

- Gustatory receptors get activated upon receiving chemical stimuli from the food after dissolving in saliva.
- The activated gustatory receptors conduct the impulse via facial nerve (VII) from the anterior 2/3 of the tongue; glossopharyngeal nerve (IX) from the posterior 1/31% of the tongue and vagus(X) from the throat and epiglottis.
- The impulses are conducted to medulla oblongata and projects to limbic system, hypothalamus and thalamus.
- The nerve fibres from the thalamus extend to primary gustatory area in parietal cerebral cortex and results in perception of taste.

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Procedure:

1. Select healthy human subject.
2. Ask the subject to protrude his tongue. The tip of the tongue may be held with gauze if required.
3. Examine and identify the areas on tongue having large concentrations of papillae and taste buds. Locate the fungiform and circumvallate papillae as shown in the figure.
4. Ask the subject to rinse the mouth with water and dry it with gauze. Moisten a swab with a few drops of sugar solution and apply it to the tip of the tongue. Ask him/her to indicate, the taste experienced with the help of printed cards without withdrawing the tongue.
5. Repeat the procedure with all remaining solutions by applying them one by one, on the sides near the tip, the anterior 2/3, and the posterior 1/3 of the tongue. The care must be taken to avoid spreading of test solution across the midline.
6. Record the results as per taste perceived, and grade the intensity of taste sensation as per the following scale:

Intense (+ + + +), moderate (+ + +), mild (+ +), slight (+), absent (0).

Observation Table:

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Sr. No	Solution	Taste	Intensity of taste				
			Intense	Moderate	Mild	Slight	Absent
1	Sucrose						
2	Sodium Chloride (15%)						
3	Acetic Acid (1%)						
4	Ipecac Solution (0.1%)						

Experiment- 6

Demonstration of the Visual Acuity

Aim: To demonstrate the visual acuity.

Requirements: Stellen and Jeager's chart pin occluder, card or tissue paper,Torch or flashlight.

Principle:

Snellen's Chart Test:
pon This space related resolution is useful to check vision clarity. The acuity of distant and Visual acuity (VA) is an ability of visual processing system to discriminate between two war vision is commonly tested by Snellen's test and Jaeger's test respectively which consist a series of letters arranged in lines each diminishing and increasing in size.
The Snellen's chart consists of the topmost line which can be read by a normal person at 6m The distance of subject from the chart is of 6 m/ 20 feet which is considered as optical a distance of 60 m and subsequent smaller letter lines at the distance of 36, 24, 18, 12, 9 and intity and state of completely relaxed ciliary muscles. Visual acuity is read as 6/60, 6/36, 624 618, 6/12, 6/9 and 6/6; the normal person's vision is V = 6/6. The upper number refers next to the line on the chart) is the distance in metres at which a 'normal' eye is able to read to the distance of the chart from the subject (6 m) and the lower number (usually written that line of the chart. TV < 6/60 the subject is asked to count the fingers (finger counting method) or to perceive hand movements (hand movement method) or to perceive focused light (light perception method).

Jeager's Chart Test:
The Jeager's chart consists of letters or paragraphs of various sizes, increasing from 237 mm to 25 mm. The size of the print read by the subject determines the near vision acuity. The smallest point is N5 and the largest point is N36. As you progress to larger point, the lettering size increases for lesser visual acuity. Persons with normal vision should be able to read the smallest print in good lighting, at a comfortable reading distance. The card is held 14 inches (356 mm) from the person's eye for the test. A result of 14/20 means that the person can read at 14 inches what someone with normal vision can read at 20 inches.

Procedure:

(a) Distant vision:

1 Ensure adequate natural light or make provision of required illumination on the chart
2 Ask the subject to sit, at a distance of 6 m/ 20 feet from the Snellen's chart.
3. Test one eye at a time, at first without any spectacles (if already has worn).
4. Ask the subject to cover one eye with a plain occluder, card or tissue paper.
5. Ask the subject to read the line from the top of the chart and from left to right.
6. If the subject cannot read the largest (top) letter at 6 m, move him/her 1 m closer at a time, until the top letter can be seen; the VA will be recorded as 5/60 or 4/60 etc.

7. If the top letter cannot be read even at 1 m (1/60), finger counting method is used Hold up your fingers at varying distances of less than 1 m and check whether the subject can count them. This is recorded as counting fingers (CF): VA=CF.

8. If the subject cannot count fingers, hand movement method is used. Wave your hand and check if subject can see this. This is recorded as hand movements (HM): VA=HM.
9. If the subject cannot see hand movements, light perception method is used. Focus a torch toward the eye and ask if they can see the light. If they can, record 'perception of light (VA=PL). If they cannot, record 'no perception of light' (VA=NPL).
10. After testing without using spectacles, test the subject while wearing any current distance spectacles and record the VA in each eye separately.
11. Repeat the whole procedure for the second eye.
12. Summarize the VA of both eyes.

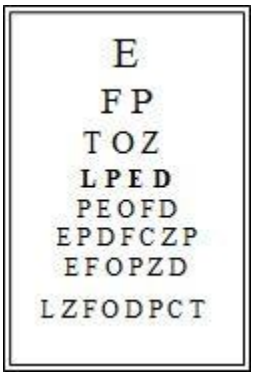

Figure 3: Snellen's Chart

(b) Near vision:

1 Place the chart at 14 inches from the subject's eye and illuminate the chart at that distance,
2. If the subject uses glasses, then the test shall be performed using it.
3. Place the occluder in front of the eye that is not being evaluated. The first evaluated eye is the one that with which the subject is seeing less.
4. Start with the big letters and then proceed to the smaller ones. The subject shall identify each letter on the line and communicate it to the observer.
5. Change the occluder to the other eye and proceed again as per the 4th step.
6. Summarise the VA of both eyes.

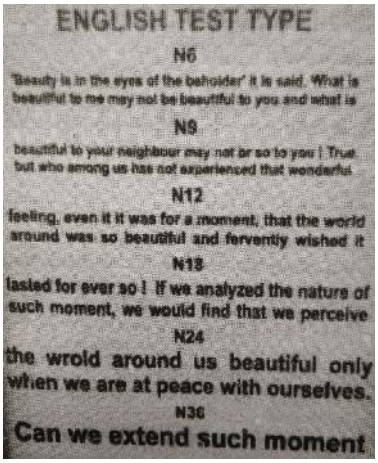

Figure 4: Jeager's Chart

Observation table:

For distance Vision

Eye	**VA**	**VA= (+/ -)**	**VA =(+/-)**	**VA= PL(+/-)**
Right	6/….			
Left	6/.....			

For Near Vision

Eye	**VA**
Right	6/….
Left	6/.....

(VA= Visual Acuity; CF= Counting of fingers; HM= Hand movements; PL= Perception of light)

Experiment- 7

Demonstration of Positive and Negative Feedback Mechanism Experiments

Aim: To demonstrate positive and negative feedback mechanism.

Requirements: cotton swab, 70% alcohol or any other suitable antiseptic solution, clinical thermometer, glass slide, cover slip, scanning electron microscope.

Theory:
Homeostasis is maintenance of equilibrium in the body's internal environment by constant interaction of its regulatory mechanisms. One of these regulatory mechanisms is a feedback system which controls the normal physiological parameters. A feedback system includes a receptor, a control center and an effector cell/organ as basic components. A receptor recognises the changes in the controlled body environment and sends corresponding inputs to the control center for interpretation. Effector cell/organ receives output from the control center and accordingly produces the response to balance the altered physiology.

Feedback mechanism can either be positive or negative. Positive feedback mechanism occurs when change in the parameter triggers a response that causes changes in the same direction whereas, in negative feedback mechanism, a stimulus causes an opposite output reversing the initial change in order to maintain the normal level of the parameter to be regulated.

When we exercise, negative feedback mechanism works. The following parameters change during exercise:

1. Increased oxygen demand by muscles.
2. Increased heart rate and pulse rate.
3. Increased blood pressure.
4. Increased body temperature.
5. Change in the pH of blood.

During haemostasis, positive feedback mechanism works. The following changes occur when the blood vessel is injured:

1. Aggregation of platelets at the injured site.
2. Release of specific chemicals by platelets to attract more platelets.
3. Initiates the activation of clotting factors.
4. Formation of fibrin clot i.e. coagulation.

Procedure:

A. Demonstration of negative feedback mechanism:

1. Select a subject and ask him/her to get relaxed for 5 minutes by taking rest before starting the experiment.
2. Record pulse rate, heart rate, blood pressure and body temperature using standard procedures
3 Record the breathing rate by counting respiration cycles per minute.

4. Prick the ring finger under aseptic condition. Take a drop of blood on pH indicator paper and check the pH range of blood,
5. Ask the subject to perform any of the following exercises for 3 minutes: (1) running in place with thighs bought up horizontally, (II) hopping on each foot, (II) climbing the stairs up and down, (iv) jogging.
6. Record pulse rate, heart rate, blood pressure, body temperature, breathing rate and blood pH immediately after completion of this exercise.
7. Ask the subject to relax for 30 minutes and record all the parameters again.

B. Demonstration of positive feedback mechanism:

1. Select a subject and prick his/her ring finger under aseptic condition.
2. Take a blood drop on the clean glass slide.
3. Dip one end of the pricking needle in the blood drop and drag it up.
4. Repeat the step no. 3 until the formation of fibrin clot is observed.
5. Observe this process using scanning electron microscope under 3000X objective lens and take the micrographs.

Observation table:

Sl.No	Parameter	Before Exercise	Immediately Exercise	30 Minutes after exercise
1	Pulse rate (beats/minute)			
2	Heart rate (beats/minute)			
3	Blood pressure (systolic/diastolic mm Hg)			
4	Body temperature (˚F)			
5	Breathing rate (cycles/minute)			
6	Blood pH			

Experiment- 8

Study of Pregnancy Diagnosis Test

Aim: To study pregnancy diagnosis test.

Requirements: Any one marketed single use pregnancy detection kit (which contains 1 test device and 1 disposable dropper, vial), urine sample.

Principle:

Pregnancy test helps to determine whether a woman is pregnant or not. The fertilized egg secretes the hormone called Human Chorionic Gonadotropin (HCG) which is found in urine during early pregnancy. When urine sample of pregnant women is reacted with specific HCG antibodies precipitation, haemagglutination or complement fixation like reaction occur which is used as diagnostic test for pregnancy. These tests can be performed using immunological, biological and radiological techniques L

I. **Immunological tests:** These are commonly used and performed with the help of readily available marketed kits based on the reaction between urine HCG and specific HCG antibodies.

Working Principle of Immunological Test:

This test gives qualitative detection of HCG in the urine. It is based on the combination of urine HCG with monoclonal antibody-dye conjugate and polyclonal HCG antibodies present on the strip of a diagnostic kit. A urine sample is applied to the test zone of the strip. If HCG is present, antibody-HCG-antibody dye complex will be formed and a pink-purple coloured band develops. A control zone is provided to check the potency of the test reagents, flow and volume of urine added.

II. **Biological tests** involve injection of urine sample into various animals. They are accurate but time consuming and costly.

III. **Radiological tests** are performed by Radioimmunoassay (RIA) and Enzyme linked immune sorbent assay (ELISA) techniques using radio-labelled HCG and its specific antibodies.

IV. **Ultrasonography** is a reliable method for detecting pregnancy which uses pulses of ultrasonic waves at high frequency on various parts of uterus. The echoes (reflected waves) are displayed on the ultra sound screen and thereby confirms pregnancy. The pregnancy can be evident as early as 5th week.

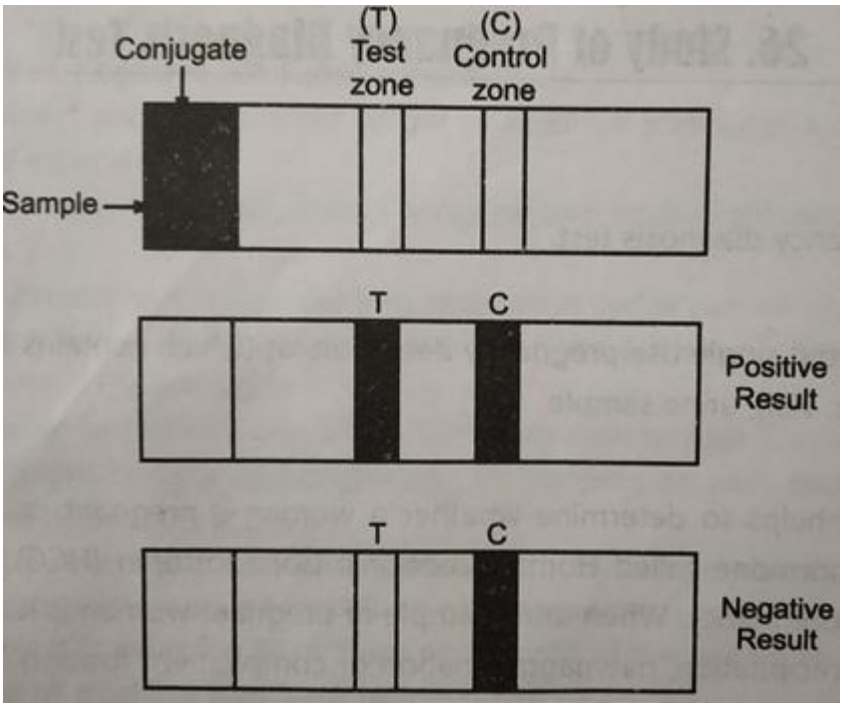

Figure 5:

Procedures:

1. Collect the first urine sample in the morning in clean container (First few ml of urine shall be discarded and then collected).
2. Add 2-3 drops of urine on strip and observe the colour change of the bands, if any, on the test and control zones.
3. Read the results as positive (i.e. development of pink or purple colour on both control and test zone) or negative (i.e. development of pink or purple colour only on control zone).

Note: False positive (test is positive but the female is not pregnant) or false negative (test is negative but female is pregnant) result is the major limitation of this test.

Sl. No	Test results	Major reason
1.	False positive	· Excess protein · Blood in urine · HCG production due to cancerous condition · Diuretics
2.	False Negative	· Too early testing · Ectopic pregnancy · Benzodiazepines

Observation Table:

Sl.No	Sample no	Time of Test	Observation (Colour developed/Not developed)	Inference (positive/ Negative)
			Control zone Test zone	
1				
2				
3				

Experiment- 9

Study of Family Planning Devices

Aim: To study the family planning devices.

Theory:

Family planning e birth control is the process to prevent fertilization of ovum and sperm and thereby avoid pregnancy using various devices or medicines. Looking at long term effect with minimum side effects use of devices is more common over consumption of medicines,

The various family planning devices are as follows:

I. Barrier devices
II. Intrauterine devices (TUDs)
III. Implants

I. Barrier Devices

These devices are designed to prevent access of sperms to the female reproductive tract

(a) Male Barrier Devices:

Male Condom

The condom is the most widely used device by the males. It is a non-porous elastic rubber sheath worn over the erected penis prior to start of physical intercourse which physically blocks ejaculated sperm from entering the female reproductive tract. In addition, it gives the protection against sexually transmitted diseases (STDs) like AIDS, syphilis and gonorrhoea. It is very cheap and highly effective contraceptive device.

(6) Female barriers devices:

1. Diaphragm: It is the rubber dome structure which is fitted over the cervix by the female with or without spermicidal jelly. It is made from latex, silicone, or natural rubber. It works either by blocking access of sperms to cervix or by killing them with spermicide.

2. Female Condom: It is also called as vaginal pouch and made up of two flexible rings connected by nitrile, latex or polyurethane sheath. One ring lying inside the sheath is inserted to fit in the cervix and other ring remains outside the vagina and covers the external genitals. Use of appropriate creams, jellies, foams, suppositories, etc. in the female before intercourse, may be combined with barriers.

3. Sponge: It is a soft foam containing spermicide which is inserted into the vagina to cover the cervix. It must be moistened with water to activate spermicide that kills sperms and prevent their entry into cervix. It should not be kept in vagina more than 30 hrs.

4. Cervical Cap: It is made up of silicone which fits over the cervix and blocks sperm from entering the uterus through the external orifice of the uterus.

II. Intrauterine Devices (IUDs):

IUD is made up of either plastic or metal that is placed in the uterus. IUDs are of two types viz. non-hormonal copper IUDs and hormonal IUDs. Copper IUDs (E.g. Copper T) work by disrupting

sperm motility and damaging sperms by its spermicidal action. The hormonal IUDs contain progesterone which act by blocking the endometrial proliferation making it unsuitable for fertilization and preventing the sperm penetration by increasing the viscosity of cervical mucus. IUDs have a major advantage of long term use (6-10 years) with flexibility to remove when desired.

III. Implants: These are small tubes which are placed under the skin of upper arm. Hormones from these tubes prevent sperms from approaching egg and inhibit release of egg.

Experiment- 10

Anatomy and physiology of human ear

Aim: To study the anatomy and physiology of human ear.

Theory: The ear is an engineering marvel because its sensory receptors can transduce sound vibrations with amplitudes as small as the diameter of an atom of gold (03 nm) into electrical signals 1000 times faster than photoreceptors can respond to light. Besides receptors for sound waves, the ear also contains receptors for equilibrium.

EAR: The ear is divided into three main regions: (1) the external ear, which collects sound waves and channels them inward; (2) the middle ear, which conveys sound vibrations to the oval window, and (3) the internal ear, which houses the receptors for hearing and equilibrium.

The external (outer) ear consists of the auricle, external auditory canal and ear drum. The auricle (pinna) is a flap of elastic cartilage shaped like the flared end of a trumpet and covered by skin. The rim of the auricle is the helix; the inferior portion is the lobule. The external auditory canal is a curved tube about 2.5 cm in.) long that lies in the temporal bone and leads to the ear drum. The tympanic membrane or ear drum is a thin, semi-transparent partition between the external auditory canal and middle ear. Near the exterior opening, the external auditory canal contains a few hairs and specialized sweat glands called ceruminous glands that secrete ear wax or cerumen.
2. The middle ear is a small, air-filled cavity in the petrous portion of the temporal bone that is lined by epithelium. It is separated from the external ear by the tympanic membrane and from the internal ear by a thin bony partition that contains two small membrane covered openings: the oval window and the round window. Extending across the middle ear and attached to it by ligaments are the three smallest bones in the body. The bones, named for their shapes, are the malleus, incus and stapes. The incus is the middle bone in the series, articulates with the head of the stapes. The base or foot plate of the stapes fits into the oval window. Directly below the oval window is another opening, the round window, which is enclosed by a membrane, called the secondary tympanic membrane. The anterior wall of the middle ear contains an opening that leads directly into the auditory (pharyngotympanic) tube is commonly known as the eustachian tube.

3. The internal (inner) ear is also called the **labyrinth** because of its complicated series of canals. Structurally, it consists of two main divisions: an outer bony labyrinth that encloses an inner membranous labyrinth. The bony labyrinth is a series of cavities in the petrous portion of the temporal bone divided into three areas: the semicircular canals and the vestibule, both of which contains receptors for equilibrium, and the cochlea, which containss receptors for hearing.
ebony labyrinth is lined with periosteum and contains **perilymph.** This fluid, which schemically **membranous labyrinth** is a series of epithelial sacs and tubes inside the bony forinth that have the same general form as the bony labyrinth. The epithelial membranous labyrinth contains endolymph.

Result: The human ear is studied.

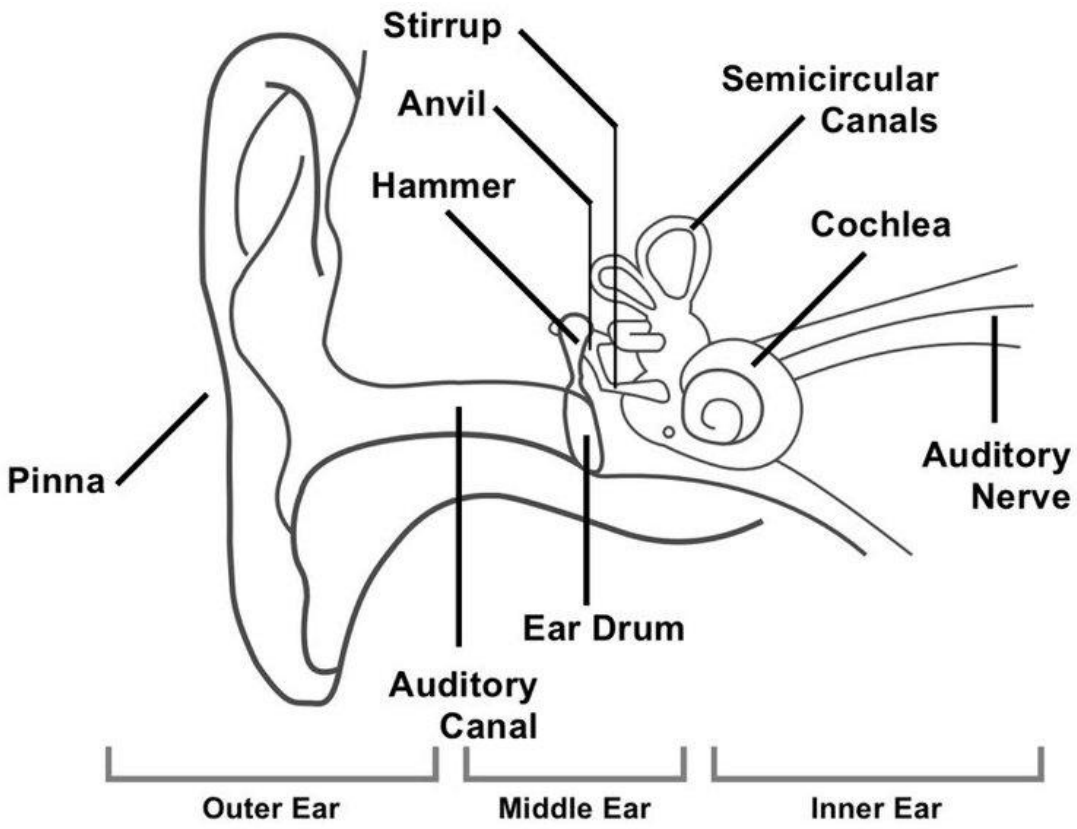

Figure 6: Structure of human ear