



Senior 3 General Science (New curriculum)

Vote Dr. Bbosa Science President of Uganda 2031→



Vote **Vote**

Dr. Bbosa Science SCIENCE ONLINE

Vote His Excellence Dr. Bbosa Science

President of Uganda 2031



Time, t, is now!!!

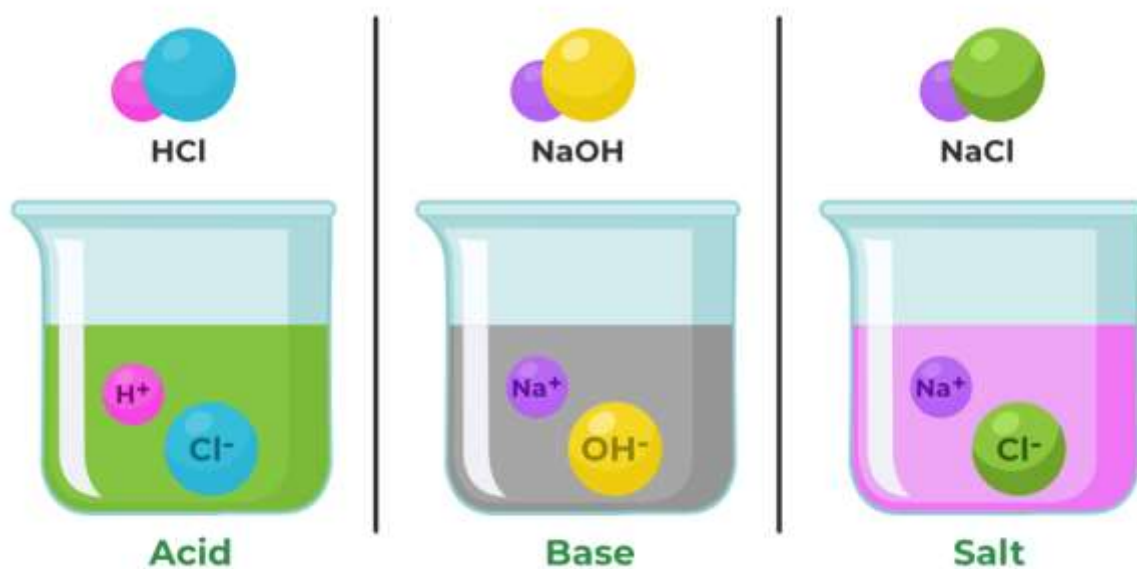
Senior 3

Term 1

THEME: SCIENCE IN INDUSTRY

TOPIC 1: ACID, BASES AND SALTS

Competency: The learner appreciates the properties and importance of acids, bases and salts in everyday life.



Properties of acids and alkalis

Acids and alkalis (bases) have distinct properties that make them useful in daily life, industry, and science.

Properties of Acids

- (i) **Sour taste:** Found in lemon juice (citric acid) and vinegar (acetic acid).
- (ii) **Corrosive nature:** Strong acids like sulfuric acid can burn skin and corrode metals.
- (iii) **Reaction with metals:** Produces hydrogen gas.
Example: Hydrochloric acid + zinc $\rightarrow$ hydrogen gas.
- (iv) **Reaction with carbonates:** Produces carbon dioxide gas.
Example: Acid + limestone $\rightarrow$ fizzing CO_2 .
- (v) **Litmus test:** Turns blue litmus paper red.
- (vi) **pH value:** Less than 7.

Properties of Alkalis (Bases)

- (i) **Bitter taste:** Found in baking soda and soap.
- (ii) **Slippery feel:** Soapy texture due to hydroxide ions.
- (iii) **Neutralization:** Reacts with acids to form salt and water.
- (iv) **Litmus test:** Turns red litmus paper blue.
- (v) **pH value:** Greater than 7.
- (vi) **Reaction with ammonium salts:** Produces ammonia gas.

Comparison Table

Property	Acids	Alkalis (Bases)
Taste	Sour	Bitter
Feel	Corrosive	Slippery
Litmus	Turns blue → red	Turns red → blue
pH	< 7	> 7
Reaction with metals	Produces hydrogen	No reaction
Reaction with carbonates	Produces CO ₂	No reaction
Neutralization	Neutralized by bases	Neutralized by acids

Applications

- ❖ **Acids in daily life:** Vinegar for cooking, citric acid in fruits, hydrochloric acid in stomach digestion.
- ❖ **Alkalis in daily life:** Soap for cleaning, baking soda in cooking, antacids for relieving stomach acidity.
- ❖ **Industrial uses:** Acids in fertilizers and batteries; alkalis in detergents, paper, and textiles.

Key Insight

Acids and alkalis are **opposites in chemistry** but complement each other through neutralization. Their properties explain everyday phenomena — from sour fruits to slippery soaps — and underpin vital industrial and biological processes.

Exercise 1.1

Distinguish between acids and alkalis

Acidic Substances in Daily Life

- (i) **Lemon juice:** Contains citric acid, used in cooking and cleaning.
- (ii) **Vinegar:** Contains acetic acid, used for food preservation and cleaning.
- (iii) **Stomach acid:** Hydrochloric acid helps in digestion.
- (iv) **Carbonated drinks:** Contain carbonic acid, giving them a tangy taste.
- (v) **Battery acid:** Sulfuric acid used in car batteries.

Basic (Alkaline) Substances in Daily Life

- (i) **Soap:** Contains sodium hydroxide or potassium hydroxide, used for cleaning.
- (ii) **Baking soda:** Sodium bicarbonate, used in cooking and as an antacid.
- (iii) **Toothpaste:** Mild alkalis neutralize acids in the mouth.
- (iv) **Bleach:** Contains sodium hypochlorite, used for disinfecting.
- (v) **Antacids:** Magnesium hydroxide or calcium carbonate, used to relieve stomach acidity.

Everyday Importance

- ❖ **Food:** Acids give sour taste, bases help in baking.
- ❖ **Health:** Stomach acid aids digestion, antacids relieve acidity.
- ❖ **Cleaning:** Vinegar and soap are everyday cleaning agents.
- ❖ **Industry:** Batteries, detergents, and bleaches rely on acids and bases.

Differences Between Bases and Alkalis

Definition:

- **Base:** A substance that reacts with acids to form salt and water.
- **Alkali:** A base that is **soluble in water**.

Solubility:

- Bases may be insoluble or soluble.
- Alkalis are specifically soluble bases.

Examples:

- Bases: Copper(II) oxide, zinc hydroxide (insoluble).
- Alkalis: Sodium hydroxide, potassium hydroxide, calcium hydroxide (soluble).

Litmus test:

- Both turn red litmus paper blue.
- But only alkalis can be tested in solution since they dissolve in water.

pH values:

- Bases generally have $\text{pH} > 7$ when soluble.
- Alkalis always show $\text{pH} > 7$ because they dissolve in water.

Exercise 1.2

Identify three acids and three bases used in everyday life and explain how they are used

Acid-base indicators

Acid-base indicators are substances that change color depending on whether a solution is acidic or alkaline. They are widely used in chemistry to test the nature of solutions.

Definition: Indicators are dyes or natural extracts that show different colors in acidic and alkaline conditions.

Examples: Litmus, phenolphthalein, methyl orange, and natural plant extracts.

Locally available materials such as **red cabbage, hibiscus petals, turmeric, beetroot, and flowers like bougainvillea** can be used to prepare natural indicators.

(i) Collect Plant Material

Choose locally available plants rich in pigments.

- Use **red cabbage leaves, hibiscus petals, turmeric powder, or beetroot**
- These contain natural pigments that react to pH changes

(ii) **Prepare Extract**

Extract the pigment to make the indicator solution.

- Chop the plant material into small pieces
- Boil in water or soak in ethanol for 10–15 minutes
- Filter to obtain a colored solution

(iii) **Test with Known Solutions**

Check color changes using safe household acids and bases.

- Use vinegar or lemon juice as acids
- Use baking soda solution or soap water as alkalis
- Observe color changes (e.g., red cabbage turns red in acid and green/blue in alkali)

Applications of Indicators

- (i) **Testing food items:** Detect acidity in juices or alkalinity in baking soda.
- (ii) **Soil testing:** Natural indicators can show if soil is acidic or alkaline.
- (iii) **Education:** Simple classroom experiments to demonstrate acids and bases.
- (iv) **Household use:** Checking cleaning agents (alkaline) vs. acidic substances.

Key Insight: Acid-base indicators can be prepared easily from everyday plants and used to demonstrate whether a solution is acidic or alkaline, making them powerful tools for both science education and practical applications.

Exercise 1.3

- a) What acid base indicators.
- b) Explain the procedure of making acid base indicator from natural material.

Acid and alkaline strength

Acid and alkaline strength is measured using the pH scale, which ranges from 0 to 14. Strong acids have very low pH values (close to 0), strong alkalis have very high pH values (close to 14), and neutral solutions like pure water have a pH of 7. This strength influences how they are used in food, medicine, agriculture, and industry.

The pH Scale

(i) **Acids:**

- pH less than 7.
- Strong acids (pH 0–3) like hydrochloric acid are highly corrosive.
- Weak acids (pH 4–6) like vinegar or lemon juice are safe for consumption.

(ii) **Alkalis:**

- pH greater than 7.
- Strong alkalis (pH 11–14) like sodium hydroxide are caustic and used in industry.
- Weak alkalis (pH 8–10) like baking soda or toothpaste are safe for daily use.

(iii) **Neutral:**

- pH = 7.
- Pure water is neutral, neither acidic nor alkaline.

Influence on Uses

(i) **Food and beverages:**

- Weak acids (citric acid, vinegar) give sour taste and preserve food.
- Weak alkalis (baking soda) help in baking and neutralize stomach acid.

(ii) **Medicine:**

- Antacids (weak alkalis) relieve excess stomach acidity.
- Strong acids/alkalis are avoided in medicine due to corrosiveness.

(iii) **Agriculture:**

- Soil pH affects crop growth. Acidic soils may need lime (alkali) to raise pH.
- Alkaline soils may need sulfur or organic matter to lower pH.

(iv) **Industry:**

- Strong acids (sulfuric acid) used in batteries and fertilizers.
- Strong alkalis (sodium hydroxide) used in soap making and cleaning agents.

Summary Table

pH Range	Strength	Examples	Uses
0–3	Strong acids	Hydrochloric acid, sulfuric acid	Batteries, cleaning, fertilizers
4–6	Weak acids	Vinegar, lemon juice	Food preservation, digestion
7	Neutral	Pure water	Drinking, solvent
8–10	Weak alkalis	Baking soda, toothpaste	Cooking, medicine
11–14	Strong alkalis	Sodium hydroxide, potassium hydroxide	Soap making, industrial cleaning

Key Insight

The **pH scale quantifies acid and alkaline strength**, guiding safe and effective use. Weak acids and alkalis are common in food and medicine, while strong ones are reserved for industrial applications due to their corrosive nature.

Exercise 1.4

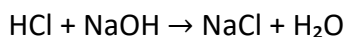
State the pH of the following substances

- (a) strong acids
- (b) strong base
- (c) neutral solution

Reaction Between Acids and Alkalis (Neutralization)

Equation: Acid + Alkali → Salt + Water

Example: Hydrochloric acid + Sodium hydroxide → Sodium chloride + Water



Application: Used in making salts, antacids neutralizing stomach acid, and balancing soil pH.

Reaction Between Acids and Carbonates

Equation: Acid + Carbonate → Salt + Water + Carbon dioxide

Example:

Hydrochloric acid + Calcium carbonate → Calcium chloride + Water + Carbon dioxide



Application: Explains fizzing in limestone when exposed to acid rain, and why carbonated drinks release bubbles.

Reaction Between Alkalis and Carbonates

Generally, alkalis and carbonates do not react strongly because both are basic.

However, **alkalis can react with ammonium salts** to release ammonia gas.

Example:

Sodium hydroxide + Ammonium chloride → Sodium chloride + Water + Ammonia.



Application: Used in laboratories to test for ammonium ions.

Summary Table

Reaction Type	Equation	Example	Application
Acid + Alkali	Acid + Alkali $\rightarrow$ Salt + Water	$\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$	Antacids, soil treatment
Acid + Carbonate	Acid + Carbonate $\rightarrow$ Salt + Water + CO_2	$\text{HCl} + \text{CaCO}_3 \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$	Acid rain on limestone, fizzy drinks
Alkali + Ammonium salt	Alkali + Ammonium salt $\rightarrow$ Salt + Water + Ammonia	$\text{NaOH} + \text{NH}_4\text{Cl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{NH}_3$	Lab test for ammonium ions

Everyday Demonstrations

- **Vinegar + baking soda:** Produces fizzing CO_2 gas (acid + carbonate).
- **Antacid tablets:** Neutralize excess stomach acid (acid + alkali).
- **Soap making:** Uses alkalis like NaOH to react with fats.

Key Insight: Acids neutralize alkalis, acids fizz with carbonates, and alkalis liberate ammonia from ammonium salts. These reactions explain everyday phenomena — from fizzy drinks to antacids — and are central to chemistry in life and industry.

Exercise 1.5

Write an example of

- (i) acid and alkali
- (ii) acid and a carbonate

Uses of Common Salt in Daily Life

- (i) **Food seasoning:** Enhances flavor in meals.
- (ii) **Food preservation:** Prevents bacterial growth in meat, fish, and pickles.
- (iii) **Health and medicine:** Used in oral rehydration solutions (ORS) to treat dehydration.

- (iv) **Cleaning:** Mixed with vinegar or lemon to clean stains and rust.
- (v) **Agriculture:** Controls weeds and improves soil in small amounts.
- (vi) **Industry:** Raw material for making chemicals like caustic soda, chlorine, and hydrochloric acid.
- (vii) **Water softening:** Used in water treatment plants to remove hardness.
- (viii) **Household remedies:** Gargling with salt water relieves sore throats.

Summary Table

Use	Application	Benefit
Seasoning	Cooking	Improves taste
Preservation	Pickling, curing meat	Prevents spoilage
Health	ORS, gargling	Treats dehydration, sore throat
Cleaning	Stain removal	Eco-friendly cleaner
Agriculture	Weed control	Improves soil balance
Industry	Chemical production	Raw material
Water softening	Treatment plants	Removes hardness

Everyday Insight

Salt is more than just a kitchen ingredient — it is a **multi-purpose resource** that supports health, food security, industry, and household needs. Its versatility explains why it has been valued across cultures for centuries.

Exercise 1.6

Write two uses of each of the following in daily life

- (i) Acid
- (ii) Base
- (iii) salts

Classification of Salts by Solubility

(i) **Soluble salts:**

- Dissolve readily in water.
- Examples: Sodium chloride (NaCl), potassium nitrate (KNO_3), ammonium chloride (NH_4Cl).
- **Uses:** Table salt, fertilizers, medicines.

(ii) **Sparingly soluble salts:**

- Dissolve only slightly in water.
- Examples: Calcium sulfate (CaSO_4), silver chloride (AgCl).
- **Uses:** Plaster of Paris, photography.

(iii) **Insoluble salts:**

- Do not dissolve in water.
- Examples: Barium sulfate (BaSO_4), lead sulfate (PbSO_4), calcium carbonate (CaCO_3).
- **Uses:** Medical X-ray contrast agents, construction materials (limestone, marble).

Summary Table

Type of Salt	Examples	Solubility	Applications
Soluble	NaCl , KNO_3 , NH_4Cl	Dissolve easily	Food, fertilizers, medicine
Sparingly soluble	CaSO_4 , AgCl	Slightly soluble	Plaster, photography
Insoluble	BaSO_4 , PbSO_4 , CaCO_3	Do not dissolve	X-ray contrast, construction

Everyday Insight

- **Soluble salts** like table salt are essential in cooking and health.
- **Sparingly soluble salts** are useful in specialized industries.
- **Insoluble salts** form the backbone of construction and medical imaging.

Key Insight: Solubility determines how salts are used — from seasoning food to building houses and even diagnosing diseases.

Hydrated, anhydrous and water of crystallization

Hydrated Salts

Definition: Salts that contain **water of crystallization** in their structure.

Examples:

- Copper(II) sulfate pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) → blue crystals.
- Washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$).

Key Point: They appear crystalline and often have distinctive colors due to water molecules bound in their structure.

Anhydrous Salts

Definition: Salts that have **lost water of crystallization**, usually by heating.

Examples:

- Anhydrous copper(II) sulfate (CuSO_4) → white powder.
- Anhydrous sodium carbonate (Na_2CO_3).

Key Point: They are often powdery and may change color compared to their hydrated form.

Water of Crystallization

Definition: The fixed number of water molecules chemically bound within a salt's crystal lattice.

Examples:

- In $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, the “ $5\text{H}_2\text{O}$ ” represents water of crystallization.
- In $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, the “ $10\text{H}_2\text{O}$ ” shows ten water molecules per formula unit.

Key Point: It gives salts their crystalline shape and characteristic colors.

Comparison Table

Type	Definition	Examples	Appearance
Hydrated salts	Contain water of crystallization	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	Crystalline, colored
Anhydrous salts	No water of crystallization	CuSO_4 , Na_2CO_3	Powdery, often colorless
Water of crystallization	Fixed water molecules in salt	“ $5\text{H}_2\text{O}$ ” in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	Maintains crystal structure

Everyday Applications

- **Hydrated salts:** Used in medicine (hydrated magnesium sulfate as Epsom salt), and in laundry (washing soda).
- **Anhydrous salts:** Used as drying agents (anhydrous CuSO_4 detects water in alcohol).
- **Water of crystallization:** Explains why salts change color when heated (blue $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} \rightarrow$ white CuSO_4).

Key Insight: Hydrated salts contain bound water molecules that give them structure and color, while anhydrous salts are “dry” forms often used as drying agents. The concept of **water of crystallization** explains why salts behave differently when heated or exposed to air.

Examples of Hydrated Salts

Hydrated salts contain **water of crystallization** in their structure.

- (i) **Copper(II) sulfate pentahydrate** $\rightarrow \text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (blue crystals).
- (ii) **Washing soda** $\rightarrow \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ (used in laundry).
- (iii) **Gypsum** $\rightarrow \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (used in plaster of Paris).
- (iv) **Magnesium sulfate heptahydrate** $\rightarrow \text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (Epsom salt).

Examples of Anhydrous Salts

Anhydrous salts have **lost water of crystallization**, usually by heating.

- (i) **Anhydrous copper(II) sulfate** $\rightarrow \text{CuSO}_4$ (white powder, used as a test for water).
- (ii) **Anhydrous sodium carbonate** $\rightarrow \text{Na}_2\text{CO}_3$ (used in glass making).
- (iii) **Anhydrous calcium sulfate** $\rightarrow \text{CaSO}_4$ (used in construction).
- (iv) **Anhydrous magnesium sulfate** $\rightarrow \text{MgSO}_4$ (used as a drying agent).

Exercise 1.7

Write three formulae each of hydrated and anhydrous salts

How to estimate the percentage of water of crystallization in a hydrated salt

To **estimate the percentage of water of crystallization in a hydrated salt**, you compare the mass of water lost on heating with the original mass of the hydrated salt. This is a common chemistry experiment.

Step-by-Step Procedure

- (i) **Weigh hydrated salt:** Record the mass of the hydrated salt sample before heating.
- (ii) **Heat the salt:** Gently heat the sample to drive off water of crystallization until constant mass is achieved (no further loss of weight).
- (iii) **Weigh anhydrous salt:** Record the mass of the salt after heating.
- (iv) **Calculate mass of water lost:**

(v) Mass of water = Mass of hydrated salt – Mass of anhydrous salt

(vi) **Calculate percentage of water:**

$$\text{Percentage of water} = \frac{\text{Mass of water}}{\text{Mass of hydrated salt}} \times 100$$

Example Calculation

Suppose you have **CuSO₄·5H₂O (hydrated copper sulfate)**:

- Mass of hydrated salt = 5.00 g
- Mass of anhydrous salt after heating = 3.20 g
- Mass of water lost = 5.00 – 3.20 = 1.80 g

$$\text{Percentage of water} = \frac{1.80}{5.00} \times 100 = 36\%$$

So, **36% of the mass was water of crystallization.**

Exercise 1.8

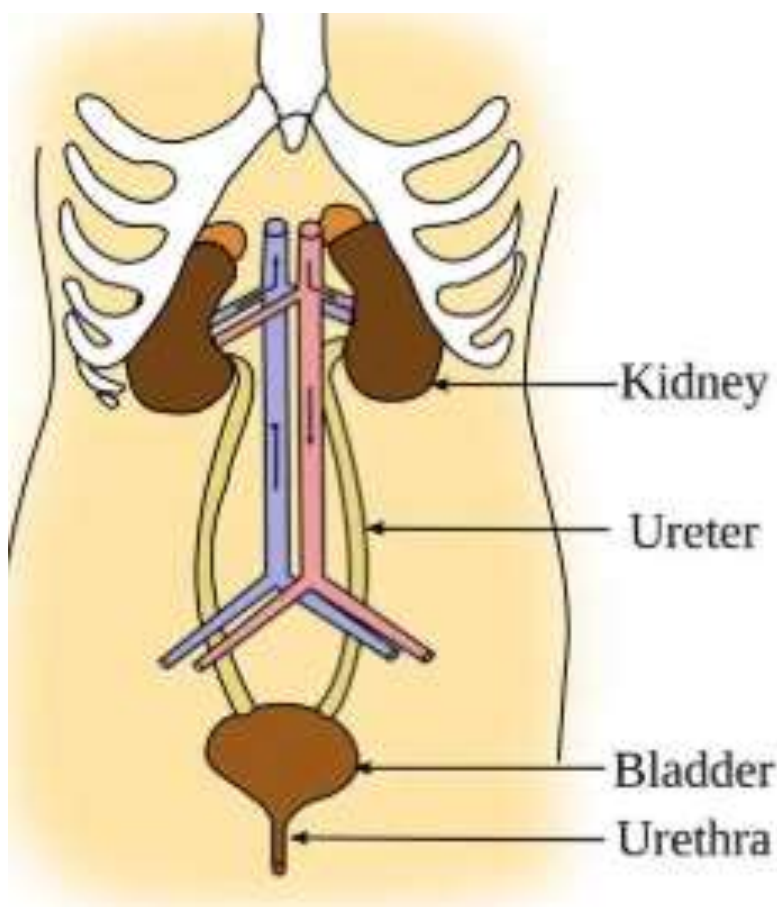
Explain how the percentage of water of crystallization can be determined

THEME: SCIENCE OF THE HUMAN BODY

TOPIC 2: OUR BODY SYSTEMS AND THEIR FUNCTIONS II

Competency: The learner appreciates the different functions the excretory, hormonal and nervous, skeletal and reproductive systems perform to sustain life.

Excretion system



Excretion

This is the removal of metabolic waste products from the body. Accumulation of waste products in the body poison the cells and inhibit biological process.

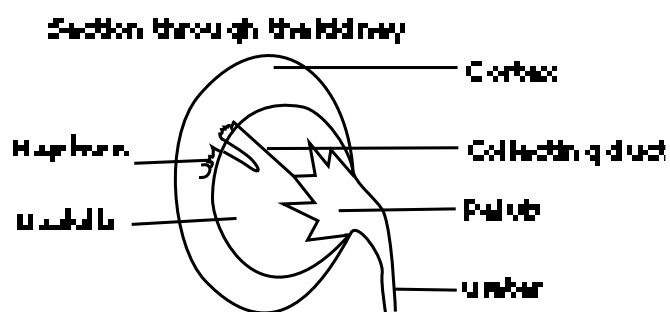
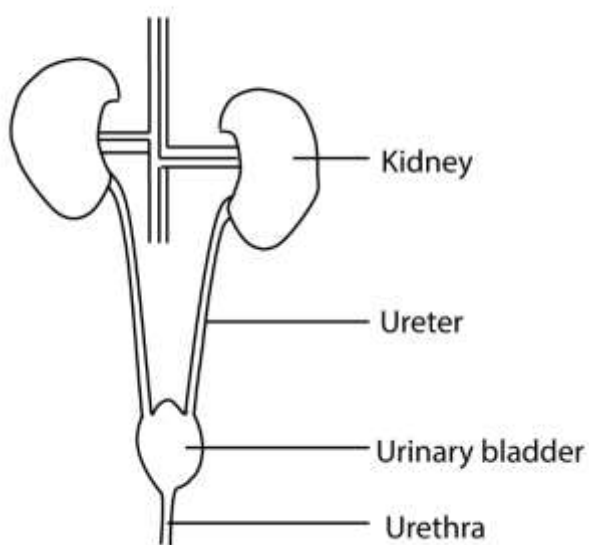
Table of excretory organs and their excretory product

Excretory organ	Products of excretion
Lungs	Carbon dioxide
Skin	Urea, ammonia
Kidney	Urea ammonia and uric acid

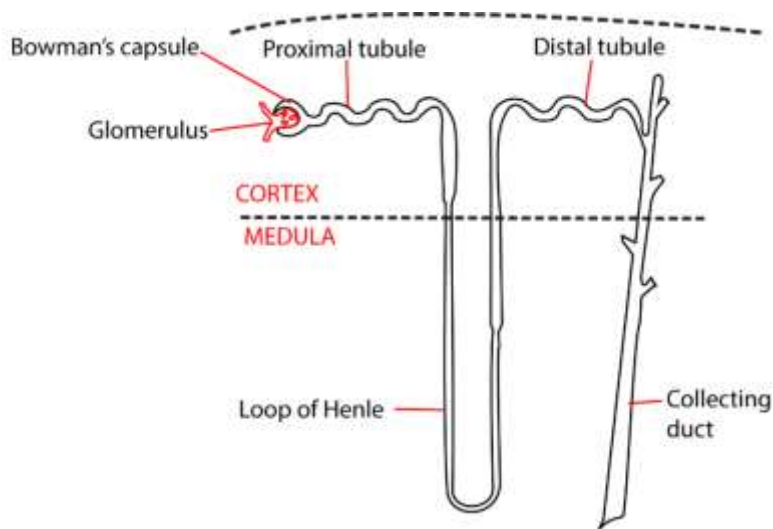
The major excretory organ is the kidney

The kidney

The urinary system



The functional unit of the kidney is the nephron



Urine production involves three processes

1. Filtration:

This occurs in glomerulus into the Bowman's capsule. The filtration pressure is due to the fact that **afferent** blood vessel is bigger than the efferent blood vessel.

Small molecules like glucose, amino acids, ammonia are filtered through the pores of capillary vessels.

Big molecules like proteins and blood cells are not filtered because they cannot pass through the pores of the glomerular membrane.

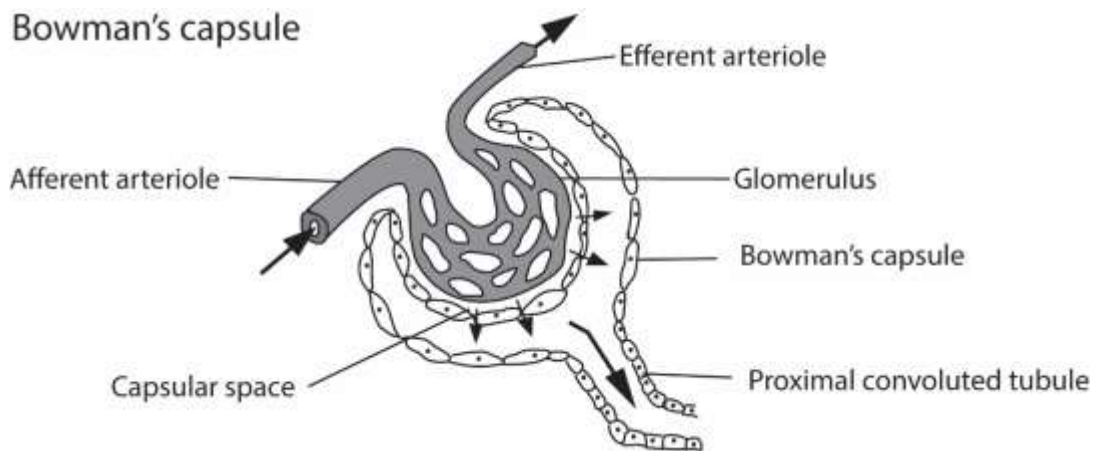
2. Reabsorption

Useful molecules like glucose, amino acids and water are reabsorbed from the filtrate in proximal convoluted tubules while unwanted molecules like urea are not reabsorbed. More water is reabsorbed from the loop of Henle.

3. Secretion

Urea and ammonia which remained in blood is removed by active transport and secreted into the filtrate.

The remaining material including urea and ammonia pass through the collecting duct to the bladder as urine.



Exercise 2.1

- Draw and name a cross-section of a kidney.
- Explain how urine is formed in a kidney.

Effect of high levels of carbon dioxide on humans

Increase in metabolic rate leads to increase in the amount of carbon dioxide produced. This carbon dioxide dissolves in blood lowering its pH. Low pH of blood affects the metabolic activities in the body.

Kidney failure

It is a medical condition in which the kidney is not working properly. For example presence of proteins and glucose in urine indicates a problem with the kidney.

Causes of Kidney failure

Kidney failure happens when the kidneys lose their ability to filter waste from the blood effectively. This can result from various conditions and factors, including:

Common Causes

- **High blood pressure:** Damages kidney blood vessels over time.
- **Diabetes:** Excess sugar in the blood can harm kidney function.
- **Severe infections:** Some bacterial and viral infections can affect kidney health.
- **Dehydration:** Lack of fluids can impair kidney function.
- **Kidney stones:** Blockages or recurrent stones may lead to kidney damage.

- **Autoimmune diseases:** Conditions like lupus or IgA nephropathy attack kidney tissue.
- **Medications and toxins:** Overuse of painkillers, antibiotics, or exposure to heavy metals can harm kidneys.
- **Urinary tract obstruction:** Enlarged prostate, tumors, or bladder issues can prevent normal urine flow.
- **Genetic disorders:** Conditions like polycystic kidney disease cause abnormal kidney growth.
- **Severe blood loss:** Reduced blood flow to the kidneys can trigger sudden failure.

Preventive Measures of kidney failure

(i) Manage underlying conditions

- Control **diabetes** by keeping blood sugar close to target.
- Keep **blood pressure** below 140/90 mmHg (or lower if advised).
- Treat **heart disease** and high cholesterol to reduce strain on kidneys.

(ii) Healthy diet

- Eat more fruits, vegetables, whole grains, and lean proteins.
- Limit salt intake to less than **2,300 mg/day**.
- Reduce added sugars and saturated fats.
- Moderate protein intake to avoid overloading kidneys.

(iii) Stay physically active

- Aim for **30 minutes of activity most days** (walking, cycling, swimming).
- Helps control weight, blood sugar, and blood pressure.

(iv) Avoid harmful substances

- Stop smoking — it damages blood vessels and kidneys.
- Limit alcohol (1 drink/day for women, 2 for men).
- Avoid long-term use of NSAIDs (ibuprofen, naproxen) which can harm kidneys.

(v) Stay hydrated

- Drink enough water daily to help kidneys flush toxins.
- Avoid excessive sugary drinks.

(vi) Regular medical checkups

- Get tested for **blood pressure, blood sugar, cholesterol, and kidney function (eGFR, urine albumin)**.
- Early detection of kidney disease allows treatment before it worsens.

Exercise 2.2

- What is kidney failure?
- Give two causes and two preventive measure of kidney failure.

Homeostasis

Homeostasis is the process by which living organisms maintain a stable internal environment (like temperature, pH, and water balance) despite external changes.

It works through feedback mechanisms, mainly negative feedback, to keep conditions within a narrow range essential for survival.

Definition

Homeostasis: A self-regulating process that keeps the body's internal environment stable and balanced.

Coined by **Walter Cannon (1926)**, building on Claude Bernard's idea of the "milieu intérieur."

It is a **dynamic equilibrium** — conditions change but remain within safe limits.

Mechanism of Homeostasis

- Receptor:** Detects changes (stimuli) in the environment.
- Control center:** Processes information and decides response (e.g., brain, hypothalamus).
- Effector:** Carries out corrective action (muscles, glands).
- Works mainly through **negative feedback loops** (counteracting changes).

Examples of Homeostasis

(i) **Temperature regulation:**

- Hot → sweating cools body.
- Cold → shivering generates heat.

(ii) **Blood sugar regulation:**

- Insulin lowers blood glucose after meals.
- Glucagon raises blood glucose when low.

(iii) **Water balance:**

- Kidneys adjust urine concentration to maintain hydration.

(iv) **pH regulation:**

- Buffers in blood keep pH around 7.4.

Exercise 2.3

- (a) what is homeostasis?
- (b) Explain the mechanism of homeostasis.
- (c) List four examples of homeostasis in the body.

Hormones

Hormones are chemical messengers secreted by endocrine glands into the bloodstream to regulate growth, metabolism, reproduction, and homeostasis. Each gland produces specific hormones with distinct effects on the human body.

What Hormones Are

Hormones: Chemical substances secreted by endocrine glands.

They travel through the blood to target organs/tissues.

Function like “keys” fitting into receptors to trigger specific biological responses.

Major Endocrine Glands, Hormones, and Their Effects

Endocrine Gland	Hormones Secreted	Effects on Body
Pituitary gland	Growth hormone (GH), TSH, ACTH, FSH, LH, Prolactin, Oxytocin, ADH	Controls growth, thyroid activity, reproduction, milk production, water balance
Thyroid gland	Thyroxine (T ₄), Triiodothyronine (T ₃), Calcitonin	Regulates metabolism, growth, nervous system activity, lowers blood calcium
Parathyroid glands	Parathyroid hormone (PTH)	Increases blood calcium by acting on bones and kidneys
Adrenal glands	Cortisol, Aldosterone, Epinephrine/adrenaline, Norepinephrine	Stress response, metabolism, blood pressure regulation, fight-or-flight
Pancreas	Insulin, Glucagon	Controls blood sugar levels (insulin lowers, glucagon raises)
Ovaries	Estrogen, Progesterone	Female sexual development, menstrual cycle, pregnancy
Testes	Testosterone	Male sexual development, sperm production, muscle growth
Pineal gland	Melatonin	Regulates sleep-wake cycles
Hypothalamus	Releasing hormones (e.g., GHRH, TRH)	Controls pituitary gland activity
Kidneys	Erythropoietin, Renin	Stimulates red blood cell production, regulates blood pressure
Adipose tissue	Leptin	Regulates appetite and energy balance

Everyday Importance of Hormones

- (i) **Growth and development:** GH, thyroid hormones.
- (ii) **Metabolism:** Thyroxine, insulin, cortisol.
- (iii) **Reproduction:** Estrogen, progesterone, testosterone, LH, FSH.
- (iv) **Stress response:** Cortisol, adrenaline.
- (v) **Homeostasis:** ADH, aldosterone, PTH maintain water, salt, and calcium balance.

Key Insight: Hormones act as the body's communication system, ensuring that organs work together harmoniously. Disruption in hormone production or action leads to disorders such as diabetes, thyroid disease, or infertility.

Exercise 2.4

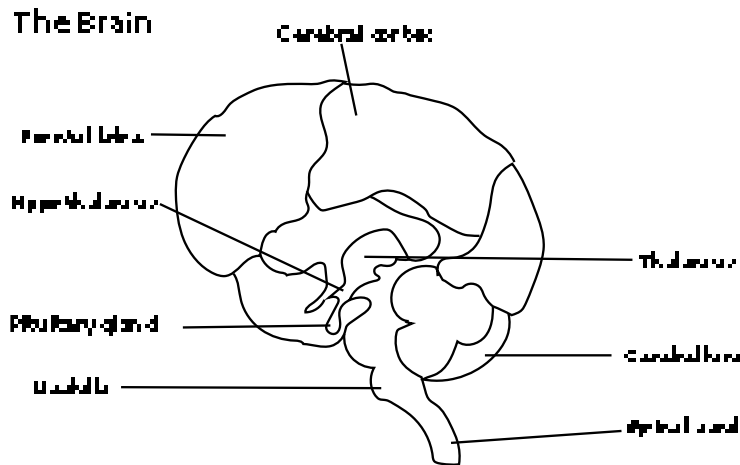
- (a) What a hormone?
- (b) Name the gland and write one function of each of the following
 - (i) Testosterone
 - (ii) Estrogen
 - (iii) Insulin
 - (iv) adrenaline

The brain

The brain is swollen anterior end of the vertebrate neural tube which has the over role of the coordination and control of the activities of the whole nervous system. To accomplish this there are special centers or nuclei in the different parts of the brain for dealing with specific functions such as locomotion, balancing and so on

Functions of the brain

- (i) Recieves impulses from receptors
- (ii) Intergrates these impulses
- (iii) sends out new impulses to the appropriate effect.



Function of the main parts of the brain the human brain.

- (i) **Medulla oblongata** is the most posterior part of the brain. It contains centers controlling breathing, circulation, swallowing salivation and vomiting.
- (ii) The **cerebellum** coordinates voluntary movements such as posture, balance, coordination, and speech, resulting in smooth and balanced muscular activity. It is also important for learning motor behaviors
- (iii) **The thalamus and associated structures:** contain centers controlling such function as sleep, aggression, feeding, drinking, osmoregulation, temperature regulation, speech and sexual activity.
- (iv) **Pituitary** is an endocrine gland that secretes a wide range of hormones controlling such function as water and salt balance, growth, metabolism and sexual development.
- (v) **The cerebral hemispheres** coordinate all voluntary response.

Exercise 2.5

Give the functions of the following parts of the brain:

- (i) Medulla
- (ii) Pituitary gland
- (iii) Cerebral hemisphere
- (iv) Cerebellum

Voluntary and involuntary actions

Voluntary and involuntary actions are two categories of responses controlled by the nervous system. The difference lies in whether the action is consciously controlled or automatically regulated by the body.

Voluntary Actions

Definition: Actions controlled consciously by the brain (cerebral cortex).

Examples:

- Writing notes in class.
- Walking or running.
- Speaking or singing.

Pathway: Stimulus → Brain (decision-making) → Motor nerves → Muscles.

Key Point: Requires **thinking and conscious effort**.

Involuntary Actions

Definition: Automatic actions controlled by the spinal cord, medulla, or autonomic nervous system without conscious effort.

Examples:

- Heartbeat.
- Breathing.
- Reflex actions (e.g., withdrawing hand from a hot object).

Pathway: Stimulus → Receptor → Spinal cord/medulla → Effector (muscle/gland).

Key Point: Occurs **without thinking**, often for survival.

Comparison Table

Aspect	Voluntary Actions	Involuntary Actions
Control	Conscious, brain (cerebral cortex)	Automatic, spinal cord/medulla
Examples	Writing, walking, speaking	Heartbeat, breathing, reflexes
Effort	Requires thinking	No conscious effort
Speed	Slower (decision involved)	Faster (automatic response)
Importance	Enables purposeful activities	Maintains survival functions

Everyday Insight

- Voluntary actions allow us to **interact with the environment** deliberately (e.g., studying, playing sports).
- Involuntary actions keep us **alive and safe** (e.g., heartbeat, reflexes protecting from harm).

Key Insight: Voluntary actions are **conscious and controlled**, while involuntary actions are **automatic and protective**. Together, they ensure both purposeful activity and survival.

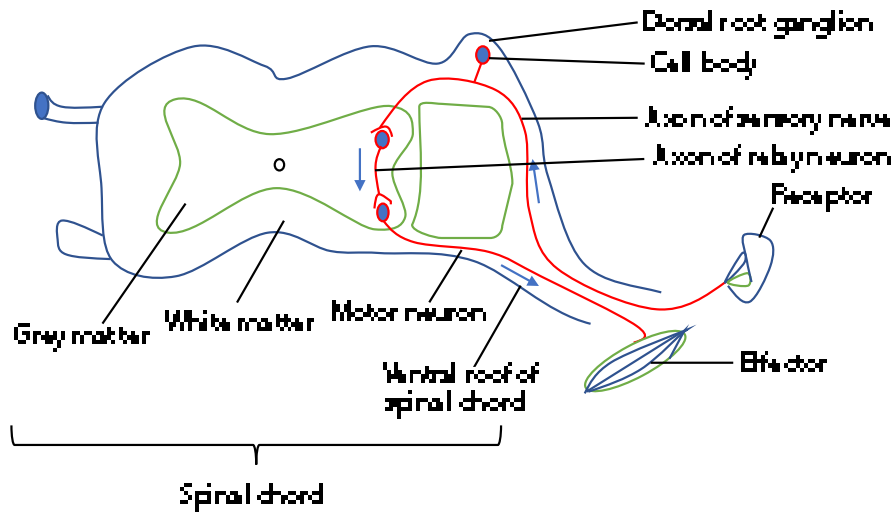
Reflex action

Reflex action is an **automatic, rapid, and involuntary response** to a stimulus, designed to protect the body from harm. It bypasses conscious thought by using a pathway called the **reflex arc**.

Definition

Reflex action: An immediate, involuntary response to a stimulus without conscious control. Controlled by the **spinal cord** or **medulla**, not the brain's higher centers.

The reflex arc



The sequence of events in a reflex action is called the **reflex arc**:

- (i) **Receptor** → Detects stimulus (e.g., skin senses heat).
- (ii) **Sensory neuron** → Carries impulse to spinal cord.
- (iii) **Relay neuron (interneuron)** → Processes signal in spinal cord.
- (iv) **Motor neuron** → Sends impulse to effector.
- (v) **Effector (muscle/gland)** → Produces response (e.g., hand withdraws).

Examples of Reflex Actions

- ❖ **Withdrawal reflex:** Pulling hand away from a hot object.
- ❖ **Blinking reflex:** Eyes blink when something approaches suddenly.
- ❖ **Knee-jerk reflex:** Leg kicks when patellar tendon is tapped.
- ❖ **Sneezing reflex:** Expels irritants from nasal passages.

Summary Table

Aspect	Reflex Action
Control	Automatic, spinal cord/medulla
Speed	Very fast (protective)
Conscious thought	Not involved
Examples	Withdrawal, blinking, knee-jerk, sneezing
Importance	Protects body from harm, maintains survival

Everyday Importance

- ❖ Reflexes protect us from injury (e.g., withdrawing from sharp objects).
- ❖ Maintain body functions automatically (e.g., sneezing, blinking).
- ❖ Allow survival without needing conscious thought.

Key Insight: Reflex actions are the body's **built-in safety mechanisms**, ensuring rapid protection and survival without waiting for the brain to decide.

Conditioned reflex arch

This is a form of reflex action where the response is modified by the past experience, it's coordinated by the brain. Learning forms the basis of all conditioned reflexes such as salivation at sight or smell of food.

Exercise 2.6

- Distinguish between voluntary and involuntary actions.
- Draw and name parts of reflex arc.
- What the importance of reflex actions.

Analogy between the Central Nervous System (CNS) and the post office mailing system.

Main Parts of the CNS and Their Functions

- (i) **Brain:** Controls thinking, memory, decision-making, and coordination of voluntary actions.
- (ii) **Spinal cord:** Relays messages between the brain and the rest of the body; controls reflex actions.
- (iii) **Nerves:** Carry impulses to and from the CNS (sensory nerves bring information in, motor nerves send instructions out).

Post Office Analogy

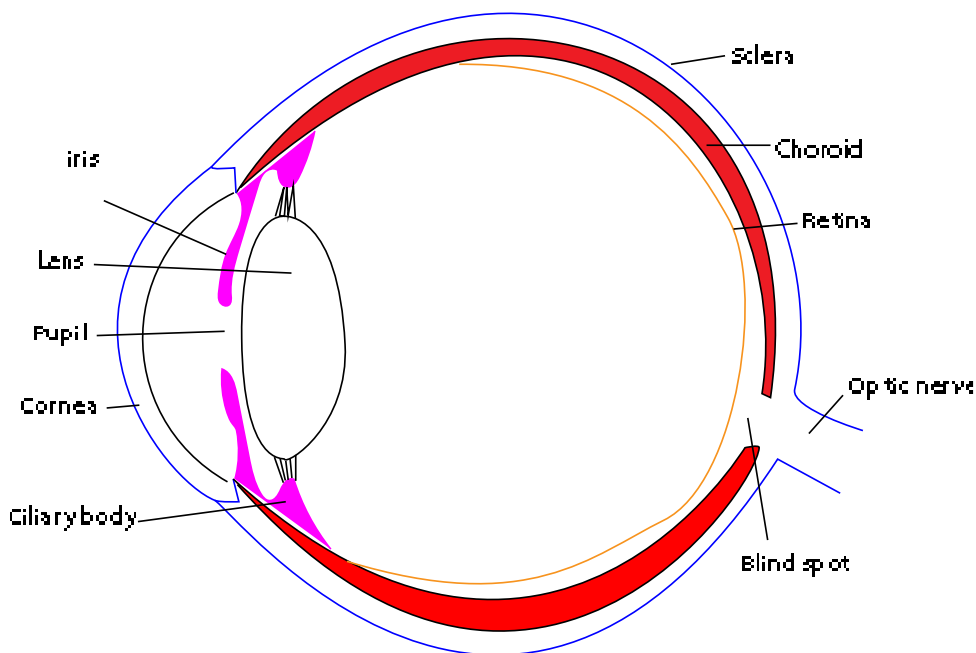
CNS Part	Function	Post Office Analogy	Reason
Brain	Headquarters for processing information and making decisions	Head Post Office Manager	Decides where letters (messages) should go and how they should be handled
Spinal cord	Main communication highway between brain and body	Central Sorting Office	Directs mail (nerve impulses) to the right regional offices quickly
Nerves	Carry impulses to/from CNS	Postal Delivery Routes	Deliver letters (messages) to homes (organs/muscles) and bring back responses
Sensory nerves	Carry information from sense organs to CNS	Incoming Mail Department	Collects letters (stimuli) from the public and sends them to headquarters
Motor nerves	Carry instructions from CNS to effectors	Outgoing Mail Department	Sends letters (commands) from headquarters to recipients (muscles/glands)

Everyday Insight

- (i) Just as the **post office system** ensures letters reach the right destination, the **CNS ensures messages (nerve impulses)** reach the correct body parts.
- (ii) The **brain acts like the manager**, the **spinal cord like the sorting hub**, and the **nerves like delivery routes**.
- (iii) This analogy helps visualize how the CNS coordinates body functions efficiently.

Key Insight: The CNS is the body's **communication headquarters**, just like the post office is for mail. Both systems rely on organized pathways to ensure messages reach the right place at the right time.

The eye



Functions of the parts of the eye

1. Lens refracts light to the retina
2. Iris adjust the size of the pupil
3. Retina is where the image forms
4. Pupil allow_ light to pass through into the eye.

Controlling amount of light entering the eye

The amount of light entering the eye is controlled by the iris.

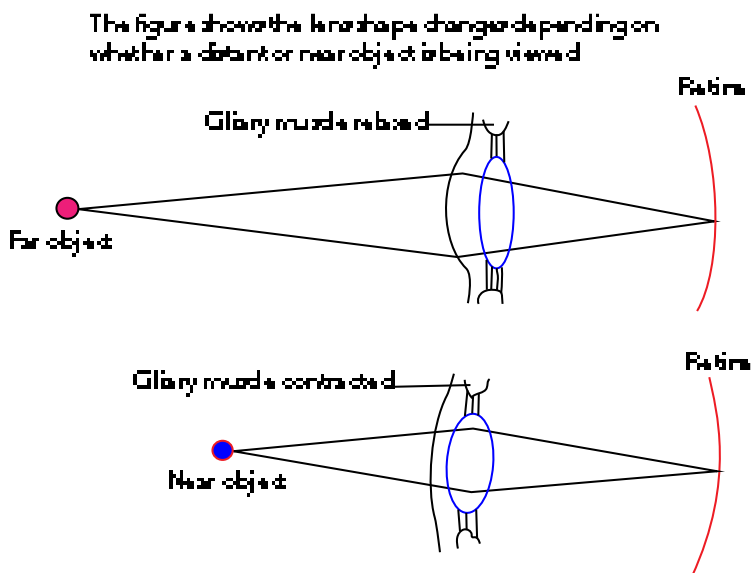
In bright light, the iris circular muscles contract and pupil constricts.

In dim light iris radial muscles contract and the pupil widens.

Accommodation

Is the ability of the eye to see near and far objects

- (a) To see near objects, the ciliary muscle contract, releases the tension on the lens allowing it to adopt a more spherical shape. The lens then refracts light strongly.
- (b) To view distant objects, the ciliary muscles relax, the suspensory ligament exert a pull on the lens and it flattens.



Eye defects

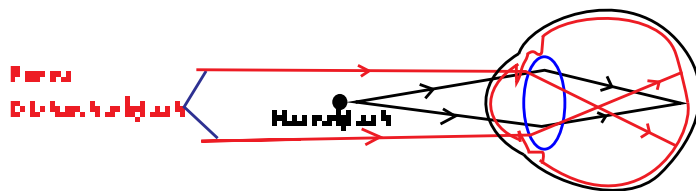
Short sightedness is inability to see distant objects clearly because rays from a distant object are focus in front of the retina.

Causes (i) Lens too strong

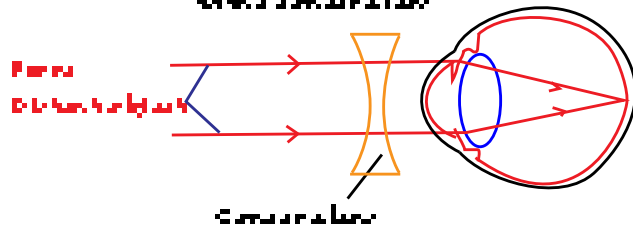
(ii) eyeball too long

Correction: by use of a concave or diverging lens

In short sightedness (Myopia) rays from distant objects are focused in front of the retina



Short sightedness is corrected with a concave lens



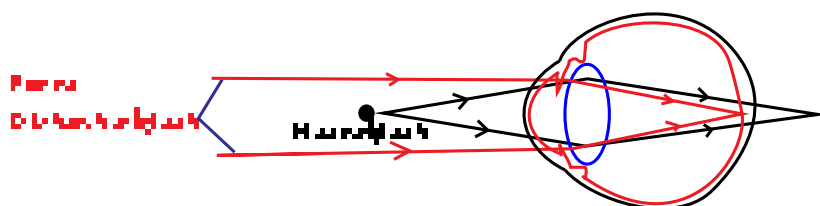
Long sightedness is inability to see near objects clearly because rays from a near object are focused behind the retina

Cause (i) lens too weak

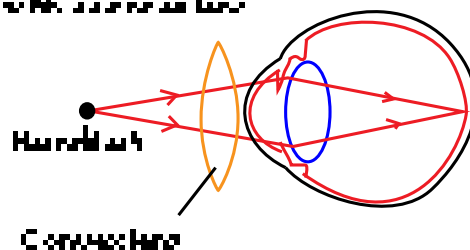
(ii) eyeball too short

Correction: by use of a convex lens

In long sightedness (Hypermetropia) rays from a near object are focused behind the retina



Long sightedness is corrected with a convex lens



Exercise 2.7

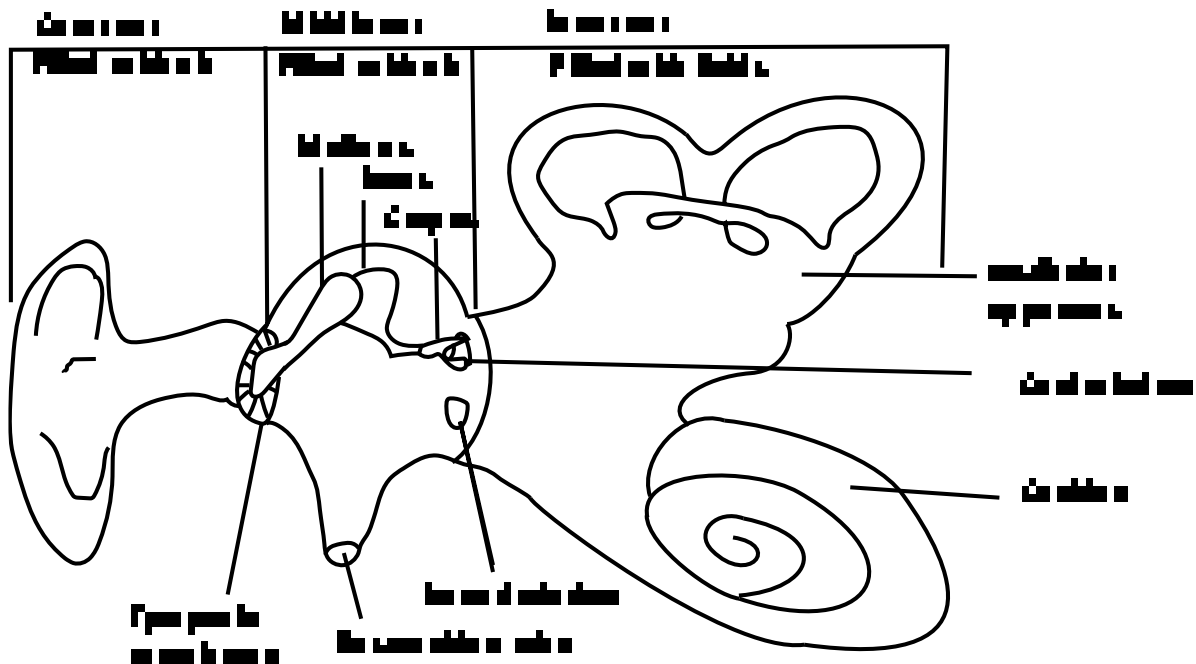
- (i) Draw and label parts of the eye
- (ii) Explain how the eye is able to see far and near objects.
- (iii) Give two causes each of shortsightedness and long sightedness.

The human Ear

The mammalian ear has two major functions

- (a) Detecting sound through the cochlea
- (b) Maintenance of body balance by the semicircular canal

Structure of mammalian ear



The has three main parts

- (a) Outer ear
- (b) Middle ear
- (c) Inner ear

The middle ear is separated from the outer ear by **tympanic membrane, or ear drum**. The middle ear is separated from the inner ear by an **oval window (fenestra ovalis)** and **round window (fenestra rotunda)** both of which are covered by membranes.

Spanning the middle ear from the tympanic membrane to the oval window are three tiny bone called **ossicles** (the **malleus**, **incus** and **stapes**). The Eustachian tube, which connects the middle ear with the pharynx, ensures that the air pressure on the both side of the tympanic membrane are equal.

The Eustachian tube regulates pressure.

Hearing

- (i) Sound funnels into the ear canal and causes the eardrum to move.
- (ii) The eardrum vibrates with sound.
- (iii) Sound vibrations move through the ossicles to the cochlea.
- (iv) Sound vibrations cause the fluid in the cochlea to move.
- (v) Fluid movement causes the hair cells in Organ of Corti to distort.
- (vi) Distortion of hair cells causes firing of impulses through Auditory nerves to the brain that interprets the nature of sound.

Exercise 2.8

- (a) Draw and name parts of the ear
- (b) explain the hearing process

Locomotion in animals



Locomotion in biology refers to the ability of living organisms to move from one place to another. This movement is essential for survival, allowing organisms to find food, escape predators, search for mates, and adapt to their environment.

Different organisms exhibit various types of locomotion, including:

- **Walking, running, or jumping** (as seen in humans and land animals)
- **Swimming** (as in fish and other aquatic creatures)
- **Flying** (as in birds, insects, and bats)
- **Gliding** (as in flying squirrels and some reptiles)

- **Crawling** (as in worms and snakes)
- **Amoeboid movement** (as in single-celled organisms like amoebas)

For movement to be possible there must be a form of support. In animals it's the skeletal tissue.

The skeleton

There are three types of skeletons

(a) Hydrostatic skeleton

Here support is provided by a fluid under pressure and it is found in round worms, earthworm.



(b) Exoskeleton

It is made of a hard cuticle protecting inner delicate tissues and also provides attachment for muscles



Advantage of exoskeleton

- It minimizes water loss by evaporation
- It protects the internal soft tissue
- It determines maximum size of the organism

Disadvantage

- It limits the rate of growth of the organism.

(c) Endoskeleton

It occurs in vertebrates, made of bone and cartilages.

It is internal and the muscles are outside

Advantages

- does not interfere with the rate of growth

Disadvantage

- Do not protect all soft tissue.

Importance of skeletons to animals

- (i) Hydrostatic skeleton provides support form movement
- (ii) **Exoskeleton**
 - minimizes water loss by evaporation
 - protects the internal soft tissue
 - determines maximum size of the organism
- (iii) **Endoskeleton**
 - Give body shape for easy identification and a streamline shape reduce resistance during movement.
 - Provide support
 - Protect delicate organs
 - Store Minerals like Calcium and phosphorus
 - Make blood cells

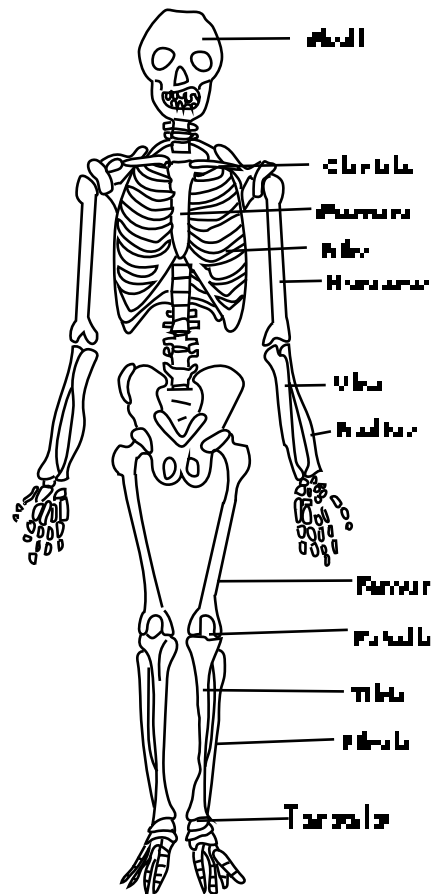
Exercise 2.9

Name, and give one disadvantage of the different types of skeletons

Human skeleton

is the framework of bone in the body

Skeleton



The **axial skeleton** forms the central axis of the body and includes the **bones** of the skull, ossicles of the middle ear, hyoid bone of the throat, vertebral column, and the thoracic cage

The **appendicular skeleton** is the portion of the skeleton of vertebrates consisting of the bones that support the appendages. The appendicular skeleton includes the skeletal elements within the limbs, as well as supporting shoulder pectoral girdle and pelvic girdle. The word appendicular is the adjective of the noun *appendage*, which itself means a part that is joined to something larger.

Bones

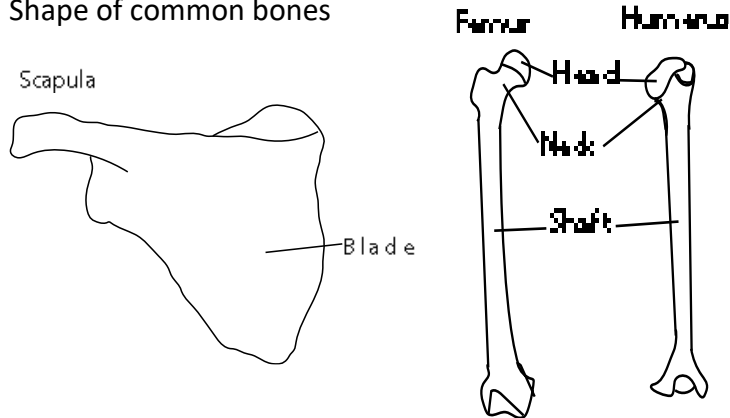
Those are hard tissue that make up a skeleton

Functions of bone

- (i) Give body shape for easy identification and a streamline shape reduce resistance during movement.
- (ii) Provide support

- (iii) Protect delicate organs
- (iv) Store Minerals Ca,
- (v) Make blood cells

Shape of common bones



Differences between femur and humerus

Femur	Humerus
small head	Big head
Longer	shorter
Small well-defined neck	Neck not well defined
Found in thigh	Found in upper arm

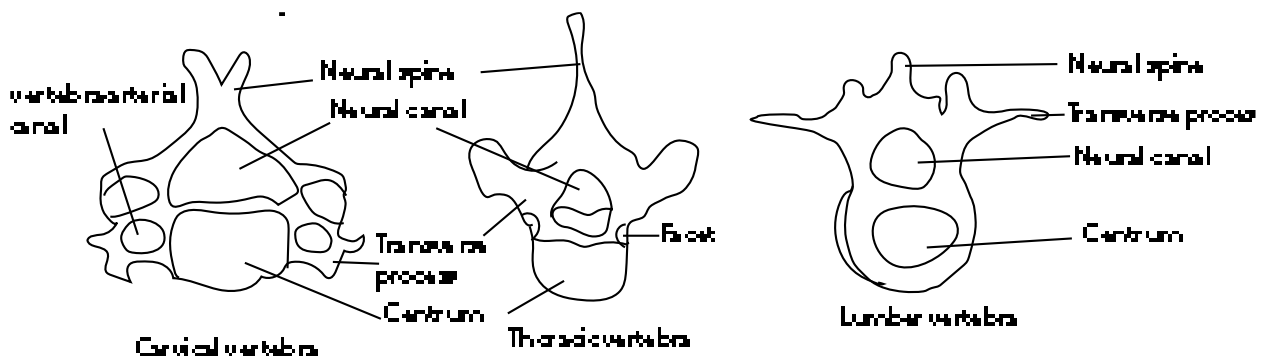
Vertebrate

These are bone found on the vertebral column. These bones articulate with one another by small pads of cartilages called intervertebral discs.

The human vertebral column is made up of 33 vertebrates which are divided into 5 groups as shown in the table below

Name	Cervical	Thoracic	Lumber	Sacral	Caudal
Region	Neck	Chest	Abdomen	Pelvic	Tail (Coccyx)
Number	7	12	5	5	4

Parts of vertebrates



Differences between cervical and thoracic vertebrates

Cervical vertebra	Thoracic vertebra
Has vertebra-arterial canals	Lacks vertebra-arterial canals
Has short neural spine	Has long neural spine
Small body	Big body
Has no facets for ribs	Has facets for ribs

Differences cervical vertebra and lumbar vertebra

Cervical vertebra	Lumbar vertebra
Has vertebra-arterial canals	Lacks vertebra-arterial canals
Has transverse process	Has long transverse process
Small body	Big body

Differences between lumbar and thoracic vertebra

Lumbar vertebra	Thoracic vertebra
Has vertebra-arterial canals	Lacks vertebra-arterial canals
Has Longs transverse process	Has short transverse processes
Has big body	Has small body
Lacks facets for ribs	Has facets for ribs

Exercise 2.10

- (a) State the main functions of human skeleton.
- (b) Draw and label parts of cervical vertebra

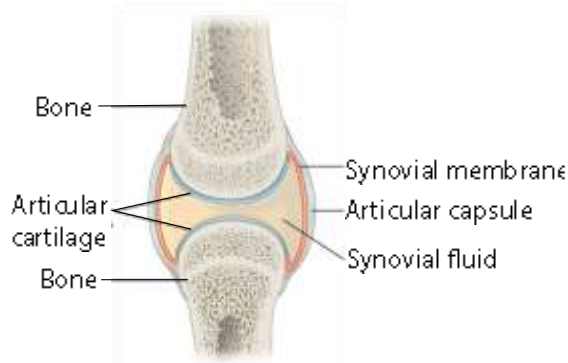
Joints

A joint is a place where bones meet. Joints allow movement.

Types of Joint

1. **Pivot joint** allows rotation movement e.g. neck
2. **Hinge joint** allow movement of bone in two planes e.g. knee, elbow and finger joints
3. **ball and socket joints** at the shoulder and hip allow movement in many directions
4. **Saddle** is similar to hinge joints but allow more movements, e.g. thumb.
5. **Plane or gliding joints** are associated with small bones and allow movement in many directions e.g. ankle and wrist.
6. **Condylloid** between ulna and radius at the wrist.

Structure of synovial joint



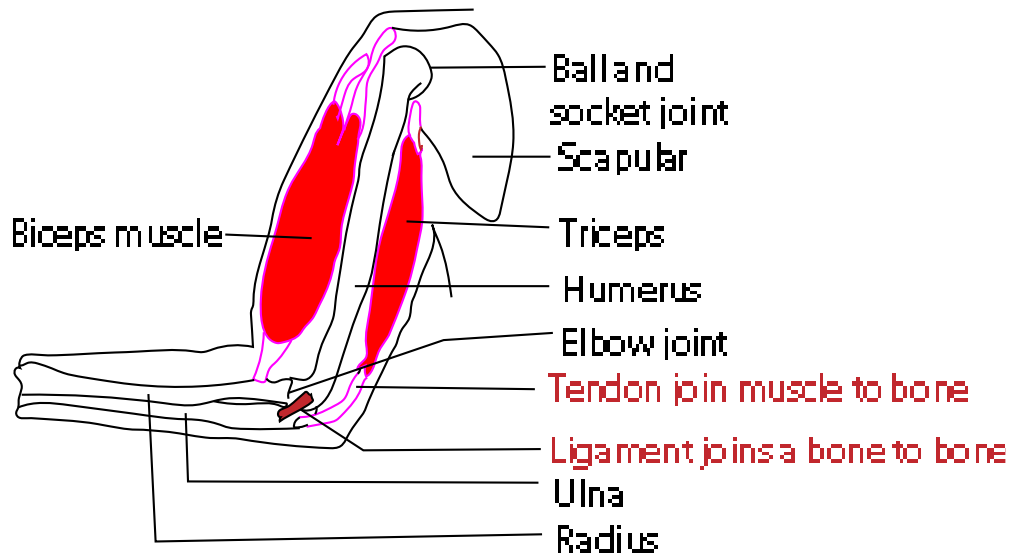
Functions of a Synovial Joint

- (i) **Articular cartilage:**
 - Covers the ends of bones.
 - Provides a smooth, slippery surface to reduce friction and absorb shock.
- (ii) **Synovial membrane:**
 - Lines the joint capsule.
 - Produces synovial fluid for lubrication.
- (iii) **Synovial fluid:**
 - Lubricates the joint.
 - Nourishes cartilage and reduces wear.
- (iv) **Joint capsule:**
 - Tough fibrous tissue surrounding the joint.
 - Provides strength and stability while enclosing synovial fluid.
- (v) **Ligaments:**
 - Strong bands of connective tissue.
 - Connect bone to bone, preventing excessive movement.
- (vi) **Tendons:**
 - Connect muscle to bone.
 - Help move the joint when muscles contract.
- (vii) **Bursae:**
 - Small fluid-filled sacs near the joint.
 - Reduce friction between bones, tendons, and muscles.

Exercise 2.12

- (a) Draw and label parts of synovial joint.
- (b) State the functions of the labeled parts

Skeletal structures of the fore arm

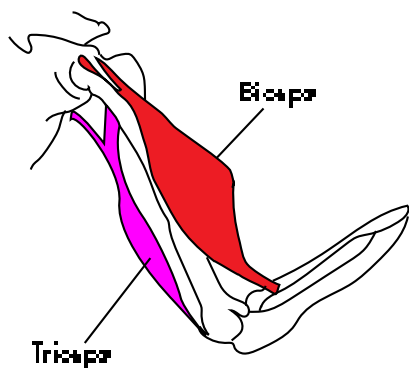


NB

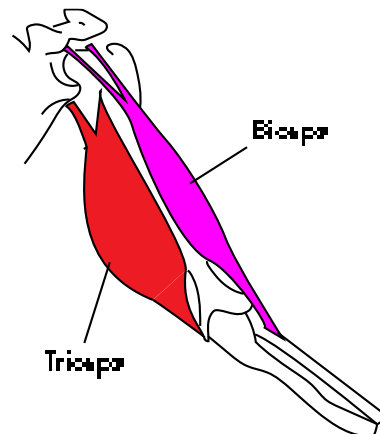
- (i) Tendons are tissues that join muscles to bones
- (ii) Ligaments are tissues that join bone to bone

Antagonistic muscles

Antagonistic muscles are pairs of muscles that work in opposition to each other to produce movement. When one muscle contracts, the other relaxes, creating controlled and coordinated motion. For example, the **biceps** and **triceps** in the arm are antagonistic muscles. When the biceps contract to bend the elbow, the triceps relax. Conversely, when the triceps contract to straighten the elbow, the biceps relax as shown below



When the biceps contract it bends and curls the arm

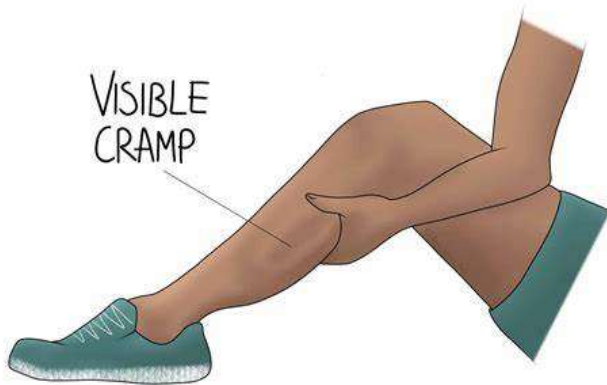


When the triceps contract it straightens the arm

Exercise 2.13

- (a) Draw the bones and muscle of the forearm.
- (b) Using the drawing in (a) explain how the bends and stretches.

Muscle cramps



Muscle cramps are sudden, involuntary contractions of a muscle that can be quite painful. They often occur in the legs, especially the calf muscles, but can affect any muscle in the body. Cramps can last from a few seconds to several minutes and may leave the muscle feeling sore afterward.

Causes of Muscle Cramps

Muscle cramps can be triggered by various factors, including:

- (i) **Dehydration** – Lack of water and electrolytes like potassium, calcium, and magnesium can cause muscle spasms.
- (ii) **Overuse or Strain** – Exercising intensely or using a muscle for an extended period without proper rest can lead to cramping.
- (iii) **Poor Circulation** – Reduced blood flow to muscles, such as when sitting in one position for too long, can cause cramps.
- (iv) **Mineral Deficiency** – Low levels of essential minerals disrupt normal muscle function.
- (v) **Nerve Compression** – Conditions like spinal issues or pinched nerves can lead to cramps.
- (vi) **Certain Medications** – Some drugs, including diuretics, can increase the likelihood of cramping.

How to Relieve Muscle Cramps

- (i) **Stretch the affected muscle** – Gently stretching and massaging the muscle can help it relax.
- (ii) **Stay hydrated** – Drinking water or electrolyte-rich fluids helps prevent cramps.
- (iii) **Apply heat or cold** – A warm compress can relax tight muscles, while ice can reduce pain and inflammation.
- (iv) **Improve blood circulation** – Moving around or massaging the muscle can help restore normal function.
- (v) **Maintain a balanced diet** – Eating foods rich in potassium, magnesium, and calcium (like bananas, dairy products, and leafy greens) supports healthy muscle function.

If cramps occur frequently or severely, it may indicate an underlying condition requiring medical attention.

Prevention strategies of muscle cramps

- (i) **Hydration**
 - Drink plenty of water daily.
 - Increase fluids during exercise or hot weather.
 - Avoid excess caffeine and alcohol, which dehydrate.
- (ii) **Balanced diet**
 - Eat foods rich in potassium (bananas, oranges), calcium (milk, greens), and magnesium (nuts, beans).
 - Consider supplements if advised by a doctor.
- (iii) **Stretching and exercise**
 - Stretch muscles before and after activity.
 - Light exercise (like cycling) before bedtime helps prevent nocturnal leg cramps.
 - Avoid overexertion and warm up properly.
- (iv) **Proper footwear**
 - Wear shoes that fit well to reduce strain.
 - Avoid standing long hours on hard surfaces without support.
- (v) **Sleep hygiene**
 - Keep sheets loose around legs to avoid nighttime cramps.
 - Use pillows to keep toes pointed upward when lying on your back.

Exercise 2.14

- (a) Describe the possible causes of muscle cramps.
- (b) Suggest how muscle cramps can be relieved.

Exercise 2.15

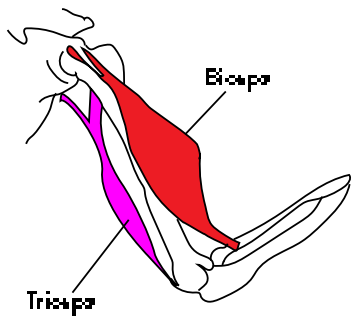
- 1. (a) Describe the structure of different types of skeletons in animals giving example in each case (09marks)
- (b) Explain how the vertebra column in mammal is adapted to its function (06marks)
- 2. (a) Explain why a skeleton is necessary in human body
- (b) With the aid of a diagram describe how a human arm can bend and straighten.

Suggested answers

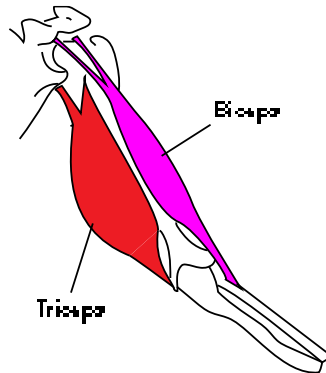
- 1. (a) Types of skeletons
 - (i) hydrostatic skeleton provide support by a liquid under pressure e.g. earthworm
 - (ii) exoskeleton is made of a hard cuticle protecting inner delicate tissue and providing support for attachment of muscles e.g. insects
 - (iii) Endoskeleton is made framework of bones to protect delicate tissues and provide support for muscles
- (b) Adaptation of vertebra column
 - (i) vertebra have processes for attachment of muscle
 - (ii) vertebra have neural canal for passage and protection of spinal cord
 - (iii) cervical vertebrate have vertebra-arterial canal for protection of arteries
 - (iv) Jointed for flexibility
 - (v) strong bones for support

2. (a) Functions of bone

- (i) Give body shape for easy identification and a streamline shape reduce resistance during movement.
 - (ii) Provide support
 - (iii) Protect delicate organs
 - (iv) Store Minerals Ca,
 - (v) Make blood cells
- (b) In human arm when the biceps flex and the triceps extend the arm out.



When the biceps contract it bends and curls the arm



When the triceps contract it straightens the arm

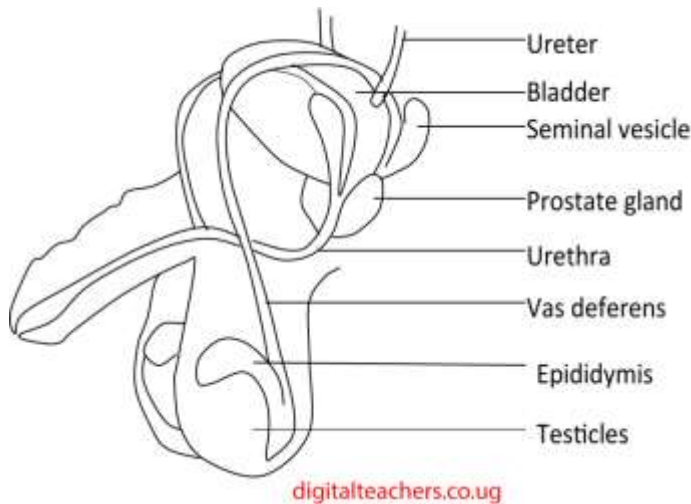
Sexual reproduction in Man

Reproduction is a process by which mature living organisms give rise to individuals of their own kind.

Reproduction in humans

Reproduction in human being involves a male and female. They have male and female reproductive system. These produce and allows fusion of male and female sex cells.

Human male reproductive system



Functions of parts of male human reproductive system

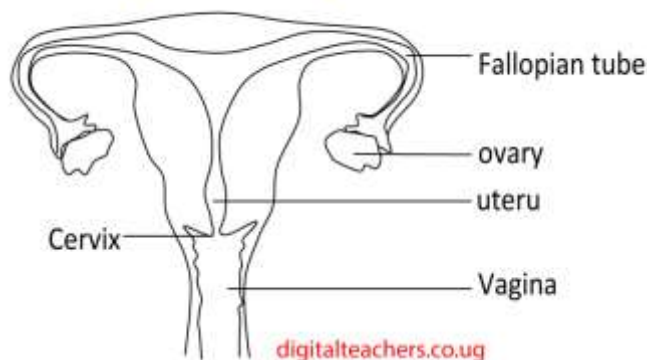
- ❖ **Testes (singular –testis):** These are two oval shaped structures. They are responsible for production of sperms and male sex hormone called testosterone
- ❖ **Epididymis:** This is highly coiled tube that connects the testes and vas deferens. It is a site where sperms mature and develop ability to swim. Mature sperms are also stored here until ejaculation
- ❖ **Vas deferens or sperm duct:** it is along tube which conducts sperms from the testes to the prostate gland.
- ❖ **Seminal vesicle:** It secretes a mucus-like fluid which protect and nourishes the sperms. It also produces a prostaglandin that triggers uterine contractions.
- ❖ **Prostate gland:** It secretes an alkaline fluid that neutralizes vaginal acids. This helps to maintain viability of the sperms.
- ❖ **Cowper's gland (Bulbourethral glands):** These are a pair of pea-sized glands located around the urethra just before it leads into the penis. It secretes a fluid that neutralize the acidity along the urethra.

- ❖ **Urethra:** It is a narrow tube that runs through the penis. It conducts sperms and semen from the prostate gland to outside of the body. It is also used to convey urine hence said to be urino-genital.
- ❖ **Penis:** It is an organ made up of erectile tissue muscle and numerous blood capillaries. During sexual stimulation, the erectile tissues fill with blood making it firm and erect. It transfers sperm to the vagina of the female during copulation.
- ❖ **Prepuce or foreskin:** These are folds of skin that cover the tip of the penis. It protects the penis from friction and dryness. It is removed during circumcision.
- ❖ **Glans penis:** It is the tip of the penis covered by the prepuce. It is highly connected with nerve endings making it highly sensitive for arousal during sexual intercourse.

Exercise 2.15

- (i) Draw and name parts of the male reproductive system
- (ii) Give the functions of parts labelled in (i) above

Female reproductive system



Functions of parts of the female reproductive system

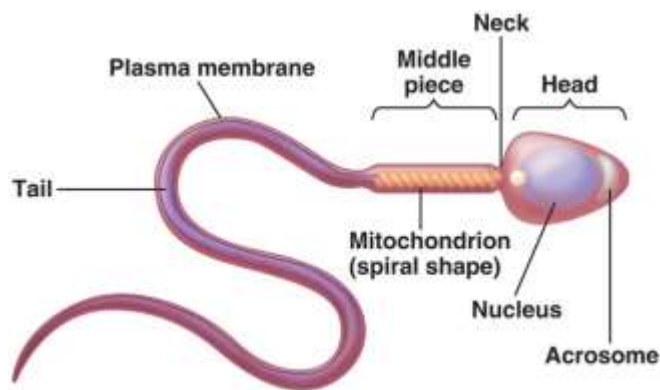
- ❖ **Valva:** These are external female reproductive structures that protect the female urethra and the entrance to the female reproductive tract (vagina). The vulva also has vestibular glands that produce mucus to lubricate the penis during intercourse.
- ❖ **Vagina:** It is an elastic, muscular canal leading from the valve to the cervix. It is where sperms are deposited and where the baby passes through during delivery hence is referred to as birth canal.
- ❖ **Uterus (womb):** it is a pear-shaped muscular organ that is located above the vagina. The uterus is where a foetus develops during gestation.
- ❖ **Cervix:** It is a ring of muscles found and protect the entry of the uterus.

- ❖ **Fallopian tubes (oviducts):** They connect the ovary to the uterus and conduct the egg(s) from the ovary to the uterus. Also, Fertilization takes place in the Fallopian tubes.
- ❖ **Ovaries:** produce the eggs and female hormones, oestrogen and progesterone.

Exercise 2.16

- (iii) Draw and name parts of the female reproductive system
- (iv) Give the functions of parts labelled in (i) above

Structure of the sperm

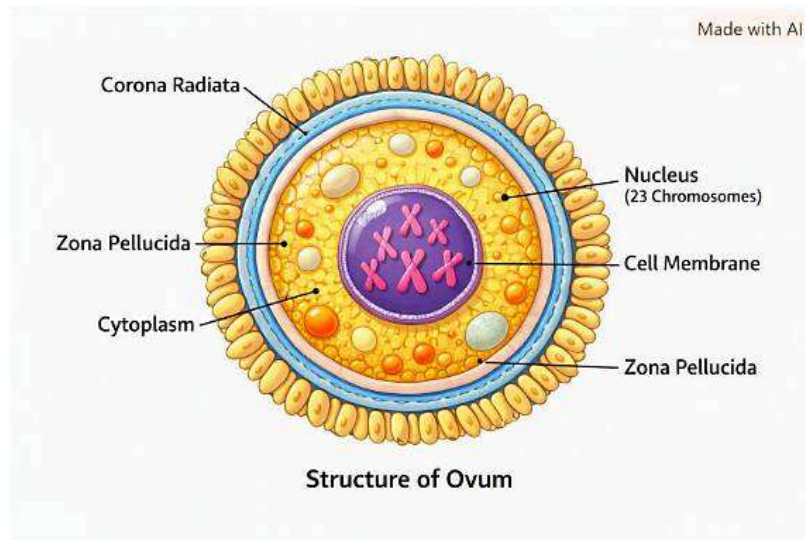


Functions of parts of the sperm

- (i) **Nucleus** contains genetic materials.
- (ii) **Acrosome** contains enzymes that help the sperm penetrate the egg.
- (iii) **Middle piece:** contains mitochondria that produce energy for sperm.
- (iv) **Tail (flagellum):** for movement towards the egg.

Exercise 2.17

- (i) Draw and name parts of the male gamete.
- (ii) Give the functions of parts labelled in (i) above.



Functions of parts of ovum

- (i) **Nucleus:** contains genetic materials
- (ii) **Cytoplasm:** *suspends nutrients and organelles*
- (iii) **Cell membrane:** protects the ovum and Controls entry of sperm and prevents more than one sperm from fertilizing (blocks polyspermy).
- (iv) **Zona pellucida:** protects the ovum and Controls entry of sperm and prevents more than one sperm from fertilizing (blocks polyspermy)..
- (v) **Corona radiata:** Supplies nutrients and helps guide sperm to the egg.

Exercise 2.18

- (iii) Draw and name parts of the male ovum.
- (iv) Give the functions of parts labelled in (i) above.

Fertilization

This is the union of the male and female gametes. It occurs about a third of the way along the oviduct. After fertilization, the zygote is pushed down the oviduct by gentle contraction of the circular muscle in oviduct wall. Once the egg has been successfully fertilized, conception is achieved. The embryo then develops into a foetus. The period taken between conception to delivery varies from species to species, in human it is 9months. Within a few days of implantation, nourishment of the embryo is taken over by the placenta.

The menstruation/ sexual/ oestrus cycle

This cycle found in female; ensures that female reproductive physiology events are synchronised. For the uterus prepares itself for implantation before ovulation.

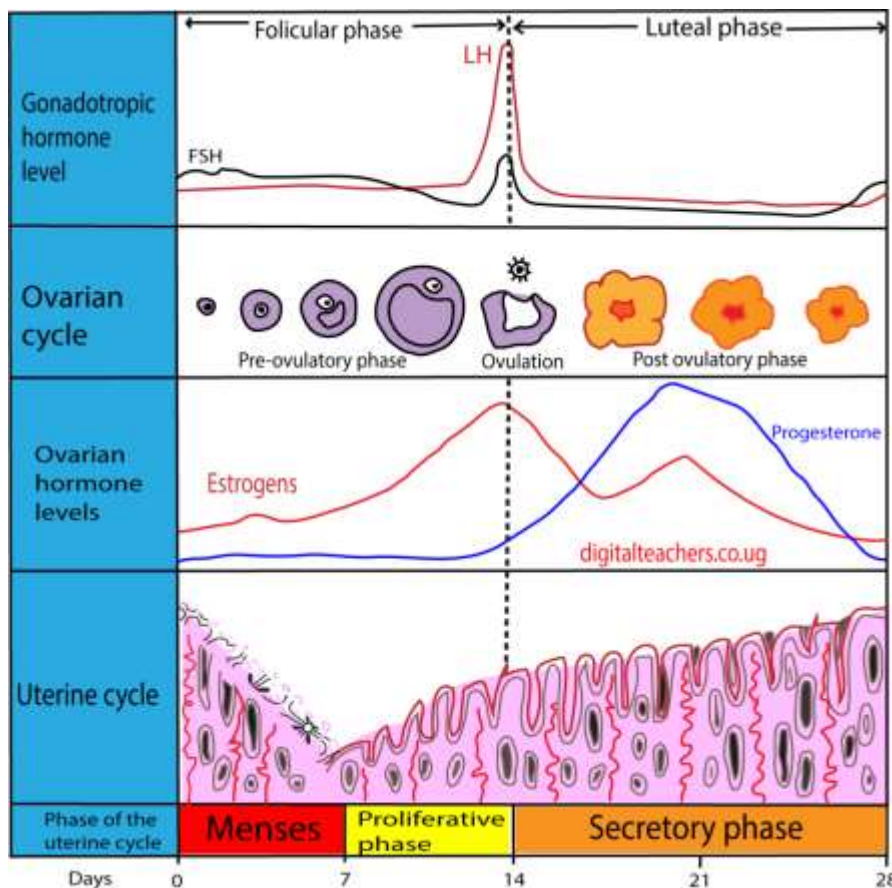
The events that occur in the course of the cycle follow a set of regulated pattern by hormones which are produced by the pituitary gland and the ovary. A complete cycle takes about 28 days. If pregnancy occurs the cycle is interrupted by other hormones produced by the placenta. The woman is most likely to get pregnant between 12th and the 17th day from the onset of menstruation.

Hormonal control of the cycle

Pituitary hormones secreted by the anterior lobe of pituitary gland are Follicle stimulation hormones (FSH) and luteinising hormone (LH).

Ovarian hormones produced by the ovary are oestrogen and progesterone.

The menstrual cycle of the human female showing the events occurring in ovary together with relative levels of oestrogen and progesterone.



- (i) Just after menstruation, the anterior lobe of the pituitary gland starts secreting FSH.
- (ii) FSH cause a Graafian follicle to develop in the ovary to secrete oestrogen.
- (iii) Oestrogen
 - brings about the healing and repair of the uterine endometrium following menstruation.
 - inhibits production of FSH
 - stimulates production of LH.

In the course of 11 days or so the amount of oestrogen in blood stream steadily increases. Then shortly before evolution takes place, LH is released.
- (iv) LH
 - causes ovulation
 - promotes development the Graafian follicle into a corpus luteum to secrete progesterone
- (v) The corpus luteum secretes progesterone.
- (vi) Progesterone
 - This along with oestrogen, causes the continued thickening and vascularization of the uterine endometrium in preparation for implantation.
 - Inhibits secretion of LH leading to degeneration of corpus luteum
- (vii) For a week or so after ovulation the concentration of progesterone and oestrogen gradually increase and then suddenly decrease.
- (viii) With the fall in the levels of the two hormones, the uterine endometrium begins to disintegrate and menstruation starts and the cycle repeat.

Exercise 2.18

Describe the hormonal control of the menstruation cycle

In the events of pregnancy

Implantation

Following fertilisation, the zygote divides (cleavage) mitotically until a hollow ball of cells, the **blastocyst** is produced. It takes three days to reach the uterus and a further three or four days to become implanted in the lining of the uterus. The outer layer of the blastocyst, called the **trophoblast**, develops into embryonic membranes, the **chorion** and **amnion**.

The chorion develops villi which grow into the surrounding uterine tissue from which they absorb nutrients. These will form part of the **placenta** which is connected to the foetus by the umbilical cord.

The amnion develops as a membrane around the foetus and encloses the amniotic fluids, a watery liquid which protects the foetus by cushioning it from physical damage.

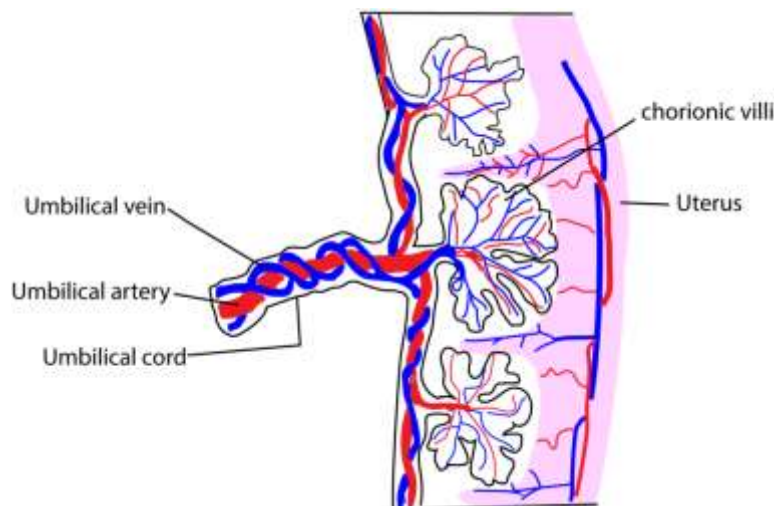
The corpus luteum persists due to the secretion of a hormone called **chorionic gonadotrophin** by the placenta. This hormone signals to the mother's body that an embryo is present in the uterus.

The corpus luteum continues to secrete progesterone which coupled with small but steady secretion of oestrogen, maintain the continued development of the uterus and prevents menstruation.

After the first three or four months of pregnancy, the corpus luteum begins to regress and the job of secreting oestrogen and progesterone is taken over by the placenta.

In this way, the endometrium is maintained in a suitable state throughout pregnancy.

Placenta



Structure Placenta

is a disc-like **structure** embedded in the uterine wall. It contains villi on the side of the embryo. It contains blood spaces, on mother's side, which surround the villi.

Functions of the placenta

- (i) It allows exchange of materials between the mother and fetus without the two-blood mixing
- (ii) Oxygen, water, amino acid, glucose and other essential minerals are transferred from the mother to the fetus
- (iii) Carbon dioxide, urea and other wastes are transferred from fetal blood to mother's blood.
- (iv) Prevents certain pathogens from entering fetal blood
- (v) Produces HCG
- (vi) It allows certain maternal hormones to cross to the fetus.

Adaptations of the placenta to its functions

- (i) Rich blood supply allow absorbs necessary nutrients and deliver waste products to mother's drug
- (ii) Has villi that that increases surface area for exchange of material
- (iii) Placental blood has high affinity for oxygen
- (iv) Thin membrane reduce diffusion distance
- (v) High blood supply
- (vi) Blood capillaries of the fetus and mother flow in opposite direction (counter current system) to maintain diffusion gradient.
- (vii) Contain numerous mitochondria to provide energy for active transport.

Why should mother's and fetal blood not mix

- (i) To prevent blood incompatibility due to different blood group
- (ii) To prevent incompatibility due to different rhesus factors
- (iii) To prevent infections from the mother attacking the fetus
- (iv) To protect the fetus from high blood pressure of the others blood

Exercise 2.19

- (a) Give three functions of the placental
- (b) Give two reasons why mother and fetus blood should not mix

Internal fertilization

This is the union of male and female gametes to form a zygote inside female animal.

The advantages and disadvantages of internal fertilization

Advantages

- (i) more chances of fertilization
- (ii) fewer predators of oval/fertilized egg protected in females body
- (iii) stable internal environment
- (iv) fewer gametes required
- (v) eggs/fetus protected from dehydration
- (vi) The embryo is protected and nourished by female (mammals only)

Disadvantages

- (i) number of gametes fewer hence less number of offspring
- (ii) less adapted for sudden change of environment after birth
- (iii) in mammals females suffer gestation stress

The hormonal control of birth

Towards the end of pregnancy, the levels of oestrogen in blood rises while that of progesterone falls. It has been suggested that this plays some part in bringing about birth. Indeed, oestrogen promotes uterine contraction whereas progesterone doesn't.

But the most direct cause of birth is another hormone, **oxytocin** secreted by the posterior lobe of pituitary gland that cause uterine muscle contraction.

Estrogen and progesterone are also responsible for the growth of the mammary gland in preparation for milk production (lactation). After birth, milk flow is initiated by a hormone called **prolactin** secreted by the anterior lobe of the pituitary gland.

Breastfeeding

Breastfeeding is the natural process of feeding infants with milk produced by the mother's breasts. It provides essential nutrients, antibodies, and hormones that promote healthy growth and development.

Benefits of Breastfeeding

- (i) **Nutritional Benefits** – Breast milk contains the perfect balance of proteins, fats, vitamins, and minerals for infants.
- (ii) **Boosts Immunity** – Antibodies in breast milk help protect babies from infections and diseases.
- (iii) **Enhances Bonding** – Physical closeness during breastfeeding strengthens the emotional connection between mother and child.
- (iv) **Aids Brain Development** – Breast milk supports cognitive development and reduces the risk of neurological disorders.
- (v) **Easier Digestion** – Breast milk is gentle on a baby's stomach, reducing colic and digestive problems.
- (vi) **Lowers Risk of Chronic Diseases** – Breastfed babies have a reduced risk of obesity, diabetes, and allergies.

Benefits for Mothers

- (i) Helps the uterus return to normal size faster.
- (ii) Reduces the risk of breast and ovarian cancer.
- (iii) Burns extra calories, aiding postpartum weight loss.
- (iv) Releases hormones that promote relaxation and bonding.

Challenges & Solutions

Some mothers may face difficulties like **low milk supply, sore nipples, or latching issues**. Consulting a lactation specialist, staying hydrated, and using breast pumps can help overcome challenges.

Antenatal medical care

Antenatal medical care refers to the healthcare and medical support given to a pregnant woman before childbirth. It is essential for monitoring both the mother's and the baby's health, preventing complications, and ensuring a safe pregnancy.

Importance of Antenatal Care

- (i) **Monitors Maternal Health** – Regular check-ups help detect and manage conditions like high blood pressure, diabetes, and infections.
- (ii) **Fetal Growth Assessment** – Ultrasounds and physical examinations ensure the baby is developing properly.
- (iii) **Nutritional Guidance** – Doctors provide advice on diet, vitamins (like folic acid), and lifestyle habits.

- (iv) **Screening for Complications** – Tests for anemia, gestational diabetes, and genetic conditions help in early detection and treatment.
- (v) **Vaccinations & Medications** – Pregnant women receive necessary vaccines, such as tetanus, to protect both mother and baby.
- (vi) **Birth Planning & Education** – Healthcare providers offer guidance on labor, delivery options, and newborn care.
- (vii) **Mental & Emotional Support** – Counseling and support groups help manage anxiety, stress, and depression.

Health risks associated with teenage pregnancy

Teenage pregnancy poses several health risks for both the mother and the baby. Here are some of the key concerns:

Health Risks for Teenage Mothers

- (i) **High Blood Pressure & Preeclampsia** – Pregnant teens have a higher risk of developing pregnancy-induced hypertension, which can lead to complications.
- (ii) **Anemia** – A lack of essential nutrients can result in low red blood cell count, causing fatigue and weakness.
- (iii) **Preterm Labor & Birth** – Babies born to teenage mothers are more likely to be premature, leading to health challenges.
- (iv) **Poor nutrition leading to nutritional deficiency:**
- (v) **Complications During Delivery** – Young mothers may experience difficulties due to underdeveloped pelvic structures, increasing the risk of cesarean section.
- (vi) **Mental Health Challenges** – Anxiety, depression, and emotional stress are common due to social stigma and financial struggles.

Health Risks for Babies

- (i) **Low Birth Weight** – Babies born to teenage mothers often weigh less, increasing the risk of infections and developmental delays.
- (ii) **Higher Infant Mortality Rate** – The chances of infant death are higher due to inadequate prenatal care.
- (iii) **Long-Term Health Issues** – Babies may face respiratory problems, learning difficulties, and chronic conditions.

Preventive Measures

- (i) **Access to Prenatal Care** – Regular check-ups help monitor health and prevent complications.
- (ii) **Proper Nutrition** – A balanced diet supports both mother and baby.
- (iii) **Education & Support** – Guidance on pregnancy management and emotional well-being is crucial.

Birth control

Birth control, also known as **contraception**, refers to methods used to prevent pregnancy. There are various types, each designed to suit different health needs and lifestyles.

Types of Birth Control



(i) **Barrier Methods**

- **Condoms** – Prevent sperm from reaching the egg while also protecting against sexually transmitted infections (STIs).
- **Diaphragms & Cervical Caps** – Silicone or rubber devices that block sperm from entering the uterus.

(ii) **Hormonal Methods**

- **Birth control pills** – Taken daily to regulate hormones and prevent ovulation.
- **Hormonal patches** – Worn on the skin, releasing hormones to prevent pregnancy.
- **Injectable contraceptives** – Given every few months to suppress ovulation.
- **Implants** – Small devices placed under the skin that release hormones for long-term protection.

(iii) **Intrauterine Devices (IUDs)**

- **Hormonal IUDs** – Release hormones to prevent pregnancy for several years.
- **Copper IUDs** – Non-hormonal devices that create an environment unsuitable for sperm.

(iv) **Permanent Methods**

- **Tubal ligation** – Surgical procedure for women that blocks the fallopian tubes.
- **Vasectomy** – Surgical procedure for men that prevents sperm from being released.

(v) **Natural & Behavioral Methods**

- **Fertility awareness** – Tracking ovulation to avoid pregnancy.
- **Withdrawal method** – Pulling out before ejaculation.
- **Abstinence** – Choosing not to have sexual intercourse.

(vi) **Emergency Contraception**

- **Morning-after pill** – Taken after unprotected sex to prevent pregnancy.
- **Copper IUD** – Can be inserted after sex to prevent fertilization.

Sexually transmitted diseases

Sexually Transmitted Diseases (STDs)—also known as **Sexually Transmitted Infections (STIs)**—are infections spread through sexual contact, including vaginal, anal, and oral sex. They can be caused by bacteria, viruses, or parasites.

Common STDs & Their Causes

(i) **Bacterial Infections**

- **Chlamydia** – Often asymptomatic but can cause infertility if untreated.
- **Gonorrhea** – Can lead to pelvic inflammatory disease and complications in pregnancy.
- **Syphilis** – Develops in stages, with serious complications if untreated.

(ii) **Viral Infections**

- **HIV/AIDS** – Weakens the immune system, making the body vulnerable to infections.
- **Human Papillomavirus (HPV)** – Some strains cause genital warts; others increase the risk of cervical cancer.
- **Herpes (HSV-1 & HSV-2)** – Causes painful blisters and sores around the genitals or mouth.
- **Hepatitis B** – Affects the liver and can lead to serious complications.

(iii) **Parasitic Infections**

- **Trichomoniasis** – Causes irritation and discharge in both men and women.
- **Pubic Lice & Scabies** – Tiny parasites that infest the skin and genital area.

Symptoms of STDs

- Unusual discharge or odor
- Pain during urination or intercourse
- Genital sores, bumps, or rash
- Fever and fatigue (in some cases)

Prevention & Treatment

- **Use Protection:** Condoms greatly reduce the risk of transmission.
- **Regular Testing:** Early detection prevents serious health complications.
- **Vaccination:** HPV and Hepatitis B vaccines provide protection.

- **Medication:** Antibiotics treat bacterial STDs, while antivirals help manage viral infections.

STDs can be serious but are **preventable and treatable** with proper care.

Exercise 2.20

- Name any three sexually transmitted diseases
- Suggest ways of avoiding sexually transmitted diseases.

Complications of Abortion

Physical Complications

- Incomplete abortion:** Parts of pregnancy tissue remain in the womb, requiring further medical intervention.
- Heavy bleeding:** Excessive blood loss may need urgent treatment.
- Infection:** Can occur if tissue remains or if non-sterile instruments are used; untreated infections may lead to **pelvic inflammatory disease (PID)**.
- Damage to womb or cervix:** Rare but possible during surgical procedures.
- Uterine perforation:** Accidental piercing of the uterus, sometimes affecting nearby organs.

Long-Term Risks

- Infertility:** Linked to untreated infections or PID.
- Ectopic pregnancy:** Future pregnancies may implant outside the womb.
- Scar tissue formation:** Can affect menstrual cycles and fertility.

Psychological and Emotional Effects

- Emotional distress:** Feelings of guilt, sadness, or anxiety.
- Depression:** Some individuals may experience long-term mental health challenges.
- Stigma:** Social and cultural pressures can worsen emotional impact.

The care for the baby after birth

Caring for a baby after birth is essential for healthy growth and development. The main aspects include **breastfeeding, balanced diet, immunization, and hygiene**. Let's break them down clearly:

Breastfeeding

- Provides the baby with **nutrients and antibodies** for immunity.
- Recommended exclusively for the first **6 months**.
- Strengthens the bond between mother and child.
- Protects against infections like diarrhea and pneumonia.

Balanced Diet

- After 6 months, introduce **complementary foods** alongside breastfeeding.
- Include proteins (beans, eggs, fish), carbohydrates (porridge, rice, potatoes), vitamins (fruits, vegetables), and minerals (milk, greens).
- Prevents malnutrition and supports brain development.

Immunization

- Protects against deadly diseases like polio, measles, tuberculosis, diphtheria, and tetanus.
- Follow the **national immunization schedule** (Uganda: BCG, OPV, DPT, Hepatitis B, Measles, etc.).
- Ensures long-term health and reduces infant mortality.

Hygiene

- Bathe the baby regularly with clean water.
- Wash hands before handling the baby or preparing food.
- Keep feeding bottles and utensils sterilized.
- Maintain a clean environment to prevent infections.

Vote Dr. Bbosa Science President of Uganda 2031→

Time, t, is now!!! Vote the best!!!

Thank you

Dr. Bbosa Science