UNIT 1: BITECHNOLOGY

Biotechnology:

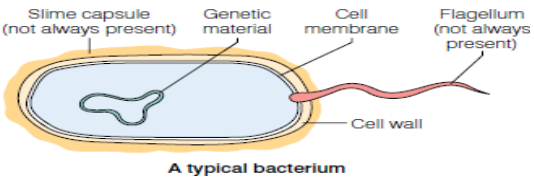
- Use of micro-organisms to make things that people want, involving industrial production.
- Used to make & preserve foods & alcoholic drinks.
- Applied based on microbiology w/c deals about micro-organisms & their effect on humans.

Micro-organisms:

- tiny living organisms including bacteria, viruses, some algae, some fungi and protoctista.
- are usually too small to be seen with naked eye.
- **Bacteria** and **fungi** are mainly used in biotechnology**.**

A. Bacteria:

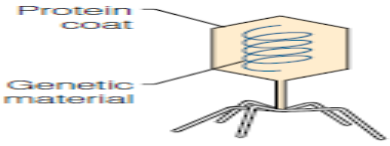
- single-celled organisms (unicellular microorganism)
- smaller than the smallest plant & animal cells.
- can reproduce very quickly by binary fission.



A typical bacterium

B. Viruses:

- Smaller than bacteria.
- do not carry out any of the normal functions of living things.
- Unable to grow or reproduce outside a host



A typical virus

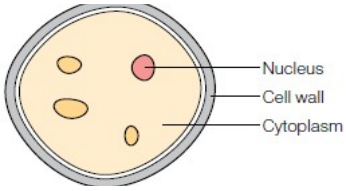
C. Fungi (Moulds & yeasts):

- Obtain their food from other dead or living organisms.

Yeasts:

- are single- celled organisms,

- has a nucleus, cytoplasm, cell membrane & cell wall
- reproduce by asexual by budding.
- One gram of yeast contains about 25 billion cells!



Moulds:

- made up of thin, thread-like structures called hyphae
- are multicellular organism
- reproduced by spore formation

Traditional Application of Biotechnology:

- Making & preserving foods such as bread, injera, cheese & yoghurt.
- Making alcoholic drinks such as beers, wines, teji &tella.

1) Traditional technology using yeast

- Yeasts are used to make fermentation food such as injera & bread
- Growth of yeast cells helps in the rise of bread or dosa dough
- Yeasts are also used to make alcoholic drinks such as teji, tella and wine

In a plenty of oxygen (the aerobic respiration),

- Yeast respires aerobically & breaking down sugar to provide energy for the cells & to produce water & carbon dioxide as waste products.
  - $C_6H_{12}O_6 + {}_6O_2 \longrightarrow {}_{36}ATP + {}_6H_2O + {}_6CO_2$
- Aerobic respiration provides more energy than anaerobic respiration, allowing yeast cells to grow & reproduce.
- At first the yeast respires aerobically, produces carbon dioxide,
- Carbon dioxide giving injera a **tangy flavour.**
- The carbon dioxide bubbles of gas expand in the high temperature, giving bread**/injera its typical texture,** which is so good for soaking up the food.

In the absence of oxygen (the anaerobic respiration),

- Yeasts respire anaerobically and break down sugar to produce **ethanol** & **carbon dioxide** which is important in the making of alcoholic drinks such as teji, tella beer & wine.
- The anaerobic respiration of yeast is referred as **alcoholic fermentation**.
- $C_6H_{12}O_6$ $\xrightarrow{\text{2ATP/enzyme (yeast)}}$ 4 ATP + 2 ethanol + CO_2

Tej making:

- Tej need **honey**, water and gesho leaf or gesho stick.
- Gesho gives a bitter edge to the brew, and yeasts for fermentation.
- Yeasts use honey as a source of food and respire anaerobically, produces ethanol & CO_2.

Wine making:

- Wine uses natural sugar, found in **fruit** such as **grapes**, as the energy source for the yeast.

2) Traditional food production using bacteria

A. Making yoghurt (irgo)

- Yoghurt is formed by the action of bacteria on the lactose (milk sugar) in the milk.
- The bacteria break down the lactose in the milk into lactic acid called **lactic fermentation**.
- Lactic acid gives the yoghurt it's;
  - **Sharp, tangy** taste.
  - Cause the milk to clot and **solidify** into yoghurt.
  - Make yoghurt a smooth, thick texture.
- Yoghurt- forming bacteria also help to prevent the growth of other bacteria that normally goes the milk bad.
- In Ethiopia, traditionally sticks such as olive tree burned into yoghurt. Which is used;
  - giving the yoghurt a **pleasant flavor**
  - **disinfects the vessel** so that only good bacteria grow in the milk



B. Cheese making (ayib)

- Like yoghurt making, Cheese making depends on the reactions of bacteria with milk **changing the texture and taste**, and also **preserving the milk**.
- Cheese making is very successful in preserving milk.
- Enzymes are also added to increase the separation of the milk.
- The bacteria in cheese making convert lactose to much more lactic acid.
- As a result, the solid part (curds) and whey(aguat) produced
  - The **whey** is often used in other dishes.
  - The **curds** the solid part contain protein and fat.

Here in Ethiopia cheese is traditionally made by;

- First making yoghurt from fresh milk,
- Extracting the butter by continuous agitation,
- Finally boiling the remaining part to make the cheese.

Review questions

1) Which of the following statements about biotechnology is not true?
   A. Biotechnology is the use of micro-organisms to make things that people want.
   B. Biotechnology is a new, modern concept.
   C. Biotechnology is based on microbiology.
   D. Biotechnology is one of the fastest-growing industries in the world.
2) How many cells does one gram of yeast contain?
   A. about 10 million B. 25 million C. 4000 million D. about 25 billion
3) Which two of the following are the waste products of anaerobic respiration in yeast?
   A. sugar B. carbon dioxide C. water D. ethanol
4) Which of the following statements about lactic fermentation is not true?

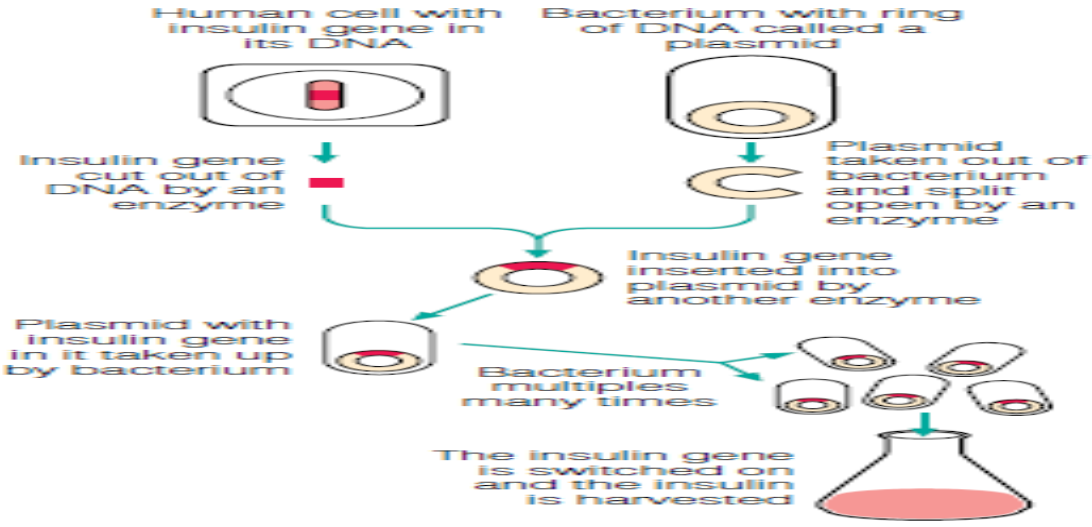
A. It gives yoghurt its sharp, tangy taste. C. It means the yoghurt will only last a few days.

B. It gives yoghurt a smooth, thick texture. D. It causes the milk to clot & solidify into yoghurt.

Modern (New) Applications of Biotechnology:

- using genetic engineering to change crops & animals
- producing new medicines
- Provide new energy sources.

- One of the most important areas of biotechnology is genetic engineering.
- **Genetic engineering/genetic modification:** is a technique of changing the organism character by inserting a new gene (genetic information) into another organism.
- It is a practice of transferring genes from one organism to another organism.
- In genetic engineering, **bacterial plasmids** (small pieces of circular DNA found in bacteria) or **viruses** are used to transfer genetic information b/n different organisms
- Genetic material carries the instructions for a new organism, found in the nucleus of every cell. For example insulin production;



Fermenters:

- Is the growing large numbers of micro-organisms on an industrial scale in large vessels.



- Industrial fermenters usually have:

1) Oxygen supply:

- provide oxygen for respiration by the micro-organism

2) Stirrer:

- keep the micro-organisms in suspension, maintain an even temperature.
- make sure oxygen and food are distributed evenly through the culture.

3) Water-cooled jacket:

- Remove the excess heat produced by the respiring micro-organisms

4) Measuring instruments:

- for continuous monitoring of factors such as pH and temperature.

The new application of biotechnology involves the ff areas:

1. Applications of biotechnology in agriculture

- Using genetic engineering, we can introduce new variety of plants and animals.

☝ **Engineered genes** can be used to;

- Improve the growth rates of plants & animals.
- Improve the food value of crops.
- make crop plants that are resistant to drought and to disease,
- Produce plants that make their own pesticide chemicals.

2. Applications of biotechnology in food

- Enzymes are produced by genetically engineered bacteria, and the enzymes are then used in;
  - The production of processed foods and drinks.
  - Clarify beer to convert starch into glucose.
  - To break down starch and convert the sugars into glucose syrup.
  - used to make meat more tender,
  - To break down the food used to make commercial baby food.
- Production of fungal protein called **mycoprotein w**hich is low in fat content and preferred by vegetarians

3. Applications of biotechnology in medicine

- It is used to develop vaccines & antibiotic.
- The first antibiotic in microbiology was penicillin introduce by Alexander Fleming (1928) from fungi penicillium notatum
- Engineered bacteria use to make drugs and hormones E.g. insulin for people with diabetes.
- Genetically modified sheep make special **blood-clotting proteins** in their milk, for people with **haemophilia**.

4. Applications of biotechnology in energy production

I. Biogas:

- Is a flammable mixture of gases formed when bacteria break down plant material or waste products of animals in anaerobic conditions.
- Is a renewable form of energy and reduce deforestation.
- **Biogas generator/digester** takes in waste material or plants, and biogas and useful fertilisers come out the other end
- The bacteria involved in biogas production work best at a temperature of around 30°C, so biogas generators tend to work best in hot countries. However, the process generates heat (the reactions are **exothermic**).
- Methane is the main component of biogas

Components	Percentage in the mixture by volume
Methane	50—80
Carbon dioxide	15—45
Water	5
Hydrogen sulphide	0-3

II. Bio fuels (ethanol)

- Ethanol-based fuels are sugar-rich products from **cane & maize** is fermented anaerobically with yeast to give ethanol and water.
- **Ethanol** use in cars and other vehicles as a fuel.
- Many cars can run on a mixture of petrol and ethanol to make a fuel called gasohol.

Advantages of ethanol as fuels

- It does not produce toxic gases when you burn it.
- It is much less polluting than conventional fuels,
- can be mixed conventional petrol used for car engine
- Using ethanol as a fuel is a carbon-neutral activity.
- **ethanol is carbon-neutral** process whereby the amount of carbon emitted is matched by the amount absorbed

Disadvantage of ethanol as fuels:

- it takes a lot of plant material to produce the ethanol
- it requires enough space and a suitable climate to grow a lot of plant material

Demerit of biotechnology/some possible problems:

- Insects may become pesticide-resistant if they eat a constant diet of pesticide forming plants
- Genetically modified crops are often not fertile w/c means farmers have to buy new seed each year
- Genes from genetically modified plants and animals might spread into the wildlife.

Review questions

1) Which of the following statements about genetic engineering is not true?
   A. It is used to change an organism & give it new characteristics that people want.
   B. It involves changing the genetic material of an organism.
   C. It can be used to produce crops that are resistant to disease.
   D. It does not allow genes to be transferred from one type of organism to another.
2) Which of the following is not a component of biogas?
   A. carbon dioxide B. ethanol C. methane D. water
3) Put the following stages of the process of making and using biogas into the correct order:

A. Some of the bacteria break down the plant cell walls while others break down the sugars formed, producing methane and other gases (3).

B. Dung or plant material is collected and put into a biogas generator, or digester (1).

C. The biogas produced is piped into homes, where it is burned to produce light, heat or refrigeration (4).

D. A mixed population of different types of bacteria is added (2).

4) Which of the following are advantages of using ethanol as a fuel, and which are disadvantages? Can you explain why?

A. It is a carbon-neutral activity. Advantage

B. It takes a lot of plant material to produce the ethanol. Disadvantage

C. It does not produce toxic gases when burnt. Advantage

D. It can be mixed with conventional petrol to make gasohol. Advantage

WORKSHEET (BIOTECHNOLOGY)

1) Which of the following is not correctly matched the alcoholic drinks and the substance on which yeast cell act on?
A. Tella-maize . C. wine-Grape C. Tej-Gesho D. Beer-barley

2) Which of the following products yeast cell is important in making injera?
A. Energy C. Carbon dioxide C. water D. Ethanol

3) Which of the following statement is true about ethanol
A. it increase accumulation of carbon dioxide C. it does not produce toxic gases
B. it is more polluting than conventional fuels D. it is not produce from sugar cane

4. Which the following produced by bacterial action.
A. Beer C. Wine C. Yoghurt D. Ethanol

5. Tell and tej are a biochemical product of;
A. bacteria C. Yeast C. Fungus D. Viruses

6. The bacterium present in curd is:
A. Salmonella typhi B. Lactobacillus C. Penicillin D. Vibrio choler

7. Milk go sour by the action of bacteria due to the production of compound called;
A. Ethanol C. carbon dioxide C. lactic acid D. water

Unit 2: Heredity

Heredity:

- Is the transmission of biological trait or characteristics from parent to offspring.

Genetics:

- Is the science that study heredity or inheritance.

Chromosomes, Genes and DNA

1) Chromosomes:

- are strand of DNA carrying genetic information
- Composed of DNA and histone protein
- homologous chromosomes are a pair of chromosomes having the same gene sequences, each derived from one parent
- The nucleus of every cell contains **chromosomes** where the genetic information passed from parent to child.
- A different type of organism has a different number of chromosomes in the cells. E.g.
  - Humans have 46 chromosomes
  - Tomatoes have 24 "
  - Elephants have 56 "
- Child inherits half chromosomes from mother and half from father.
- Human inherit 23 chromosome from each of their parent
- Chromosomes come in pairs from both parents known as **homologous pairs**
  - People have 23 pairs
  - Tomatoes have 12 pairs
  - Elephants have 28 pairs of chromosomes.
- A photograph of chromosomes in dividing human cells known as a **karyotype**.
- Human karyotypes show 23 pairs of chromosomes.
  - 22 of the pairs, are known as the **autosomes**
    - These chromosomes are the same size and shape,
    - Do not determine a boy or a girl.

- Control almost everything about the way you look and the way your body works.
  - The remaining a pair of chromosomes are known as the **sex chromosomes**
- Determine whether you are male or female
- Different for boys and girls.
- A **girl** has a pair of two similar X chromosomes**, (XX)**
- A **boy** has one X chromosome and another, much smaller, Y chromosome, (**XY)**

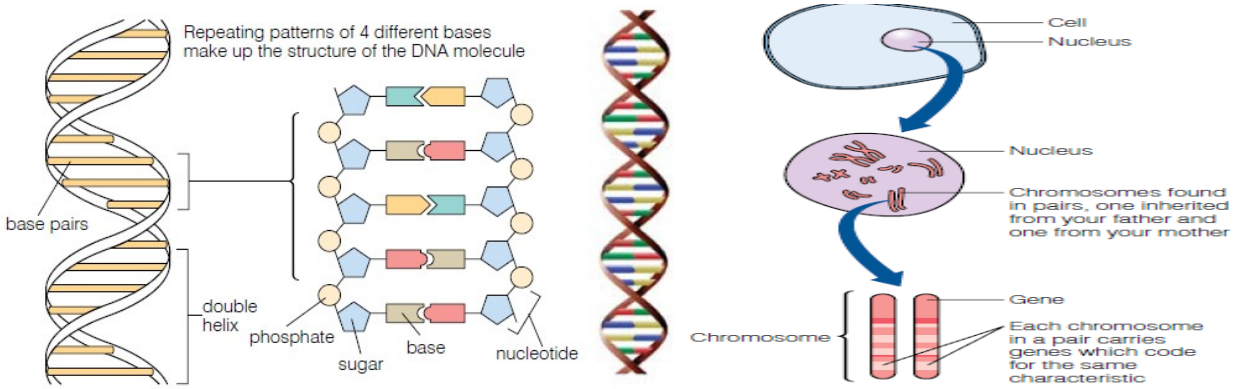
☝ **Sex determination chromosome in human**

- Everyone inherits an X chromosome from their mother.
- If it is fertilised by a sperm carrying X chromosome, you will be a girl.
- If it is fertilised by a sperm carrying a Y chromosome, you will be a boy.
- X chromosomes carry information about:
  - being female
  - the way your blood clots
  - The formation of teeth, body hair and sweat glands.
- Y chromosomes mainly carry information about maleness.

2) Deoxyribonucleic acid (DNA):

- made up of two strands twisted together to make a spiral called double helix
- genetic material contained in the nucleus.
- contain the genetic instructions used in the development and functioning of all known living organisms and some viruses
- The order of the bases in the DNA acts as a code to instruct the cell about the sequence of amino acids to make a particular protein
- Carries the instructions needed to make all the proteins in cells.
  - DNA control the production of protein
- DNA is a polynucleotide chain.

- a long molecule, made up of lots of smaller molecules (nucleotides) joined together.
- A nucleotide consists of a **phosphate group, a sugar** and a **base**. .
- Bases that make up DNA are called **adenine, thymine, guanine and cytosine**
- Cytosine & thymine are **pyrimidine** whereas guanine & adenine are **purine.**
- The upright strands of DNA are made of **deoxyribose sugar** and **phosphate**.
- The two DNA strands are linked by bases,
  - Adenine pairs with thymine (A---T)
  - Cytosine pairs with guanine.(G---C)
  - In DNA the sum of **A+G=T+C** , **A+C=G+T**
  - The number or percentage of **A=T , G=C**



3) Gene:

- is a unit of hereditary material located on the chromosomes
- is a small section of DNA.
- determine physical traits
- are repeating patterns of bases in the DNA
- Every human cell has 25,000 – 35,000 genes while human have about 10^{13} cells.

EXERCISE

1. In a DNA molecule has 40% thymine , the percentage of cytosine would be:
2. In a DNA molecule cytosine makes 30%, what is the % of thymine;

Cell division (Mitosis and meiosis)

The cell cycle

- Is a sequence of events which occurs between one cell division and the next cell division.
- Constitutes the division and non-division phase
- involves three different stages;

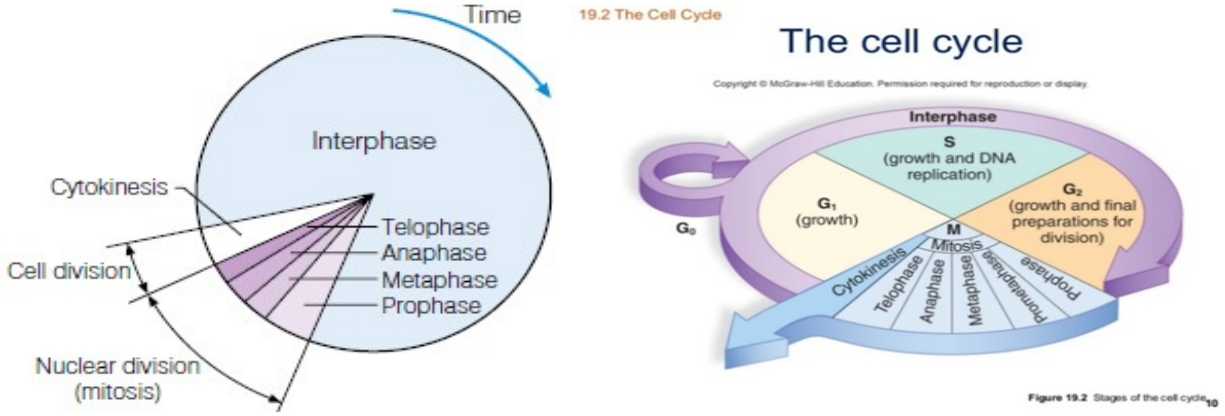
1. Interphase

- A long period of non-division phase
- Preparing the cell for division
- A period of synthesis and growth
- Replication of DNA ready for the next division.
- Parent cell has 4 chromosomes (two homologous pairs)

2. Mitosis

- A period of active cell division.
- Division of the nucleus (karykinesis)

3. Cytokinesis—division of the cytoplasm



Two main type of cell division (Mitosis & Meiosis)

1. MITOSIS: Replication division

- division of the somatic cells (body cell or non-reproductive cell) into two identical daughter cell.

- A cell nuclei divides to produce **two daughter nuclei**
- The daughter nuclei contain **identical sets of chromosomes** as in parent cell
- occurs in somatic or body cell
- helps in growth, replacement and repair of warn out/damage cells
- A method of asexual reproduction in unicellular organism
- DNA replicates and transmits genetic information when a cell reproduces and when an organism reproduces.
- It is divided into four phases

a) Prophase:

- Chromosomes are copied as the DNA replicates/duplicates
- Parent cell has four chromosomes (two homologous pairs)
- Two sister chromatids make up each chromosome, they are joined by a centromere

b) Metaphase:

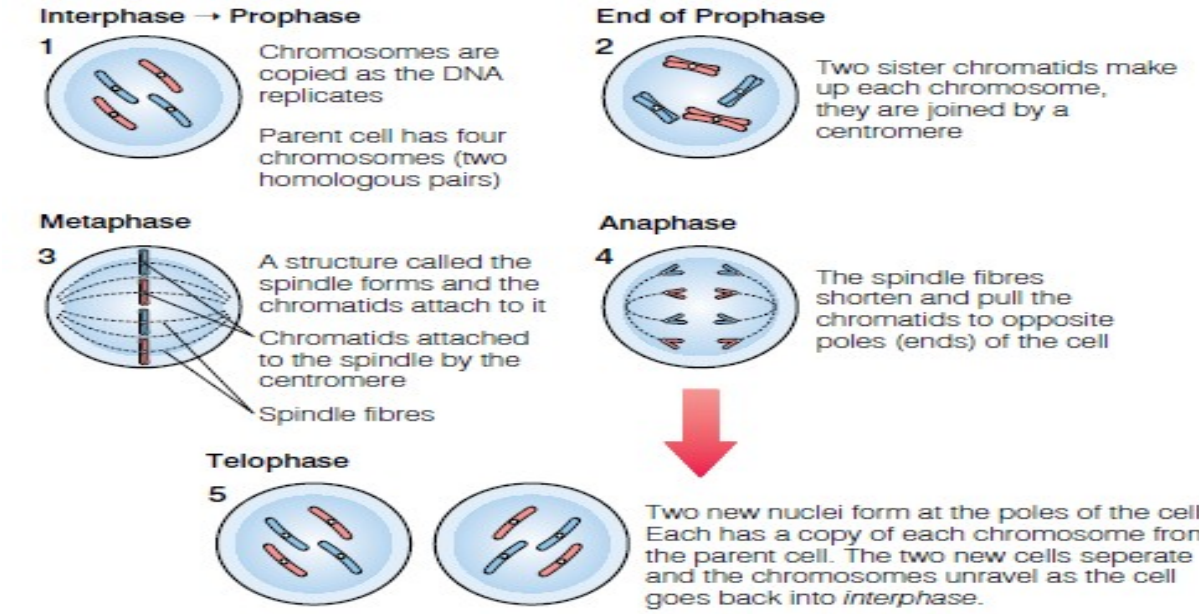
- Sister chromatids line up along the equatorial plane of the cell
- Spindle forms and chromatids attached to spindle by centromeres

c) Anaphase:

- The spindle fibers shorten and pull the chromatids to opposite poles
- The centromere and sister chromatid divide and move to the opposite pole

d) Telophase:

- Two new nuclei form at the poles of the cell.
- Each has a copy of identical chromosome from the parent cell.
- After nuclear division, the cytoplasm is divided into two equal parts.



Significance of mitosis:

- The daughter cell contain the same number of chromosome as the parent cell
- The daughter cells carry the same hereditary information as in the parent cell
- There is no variation in genetic information
- It gives genetic stability within a population

2. Meiosis: Reduction Division

- division of sex cells resulting in daughter cell with half the original number of chromosome
- Occur in reproductive organ (germ cells or sex organ or gonads) namely ovary and testes
- Result in genetically different **4 non-identical haploid cells** per division
- **Haploid (n):** has a single set of chromosome
- **Diploid (2n):** has homologous pairs of chromosomes
- **E.**g., human skin contains 46 chromosomes while sperm cell contains 23 chromosomes.
- Each having half the chromosome number of the original cell

- Important in the production of gametes (sperm and egg cell)
- Responsible for the transmission of hereditary information from generation to generation
- It involve two successive division

Meiosis I (reduction):

- Pairing of homologous chromosomes
- Exchange of genetic material in the process called **crossing over**
- Separation of homologous chromosomes

Phases of meiosis

Meiosis I

a) Prophase I

- Each chromosome appears in the condensed form with two chromatids.
- Homologous pairs of chromosomes associate with each other
- Crossing over occurs

b) Metaphase I

- The spindle forms and the pairs of chromosomes line up on the metaphase plate.

c) **Anaphase I**

- Homologous chromosome separate and move toward the opposite pole.
- One chromosome (pair of chromatids) from each homologous pair moves to each end of the cell.
- As a result the chromosome number in each cell is half that of the original

d) Telophase I

- The nuclear membrane reforms and the cells begin to divide.

Meiosis II (division):

- No doubling of chromosome
- Separate sister chromatide
- Production of four haploid cell

1) Prophase II: The chromosomes lie in two polar nuclei

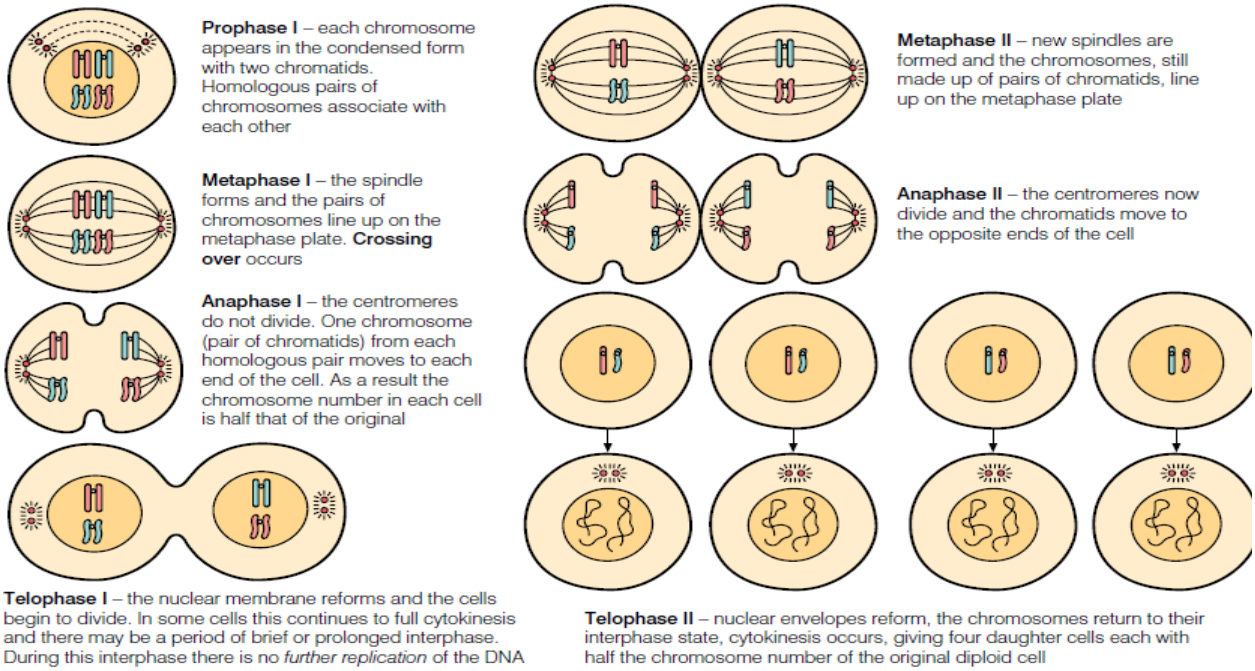
- ❖ Nuclear membrane and nucleus disappear

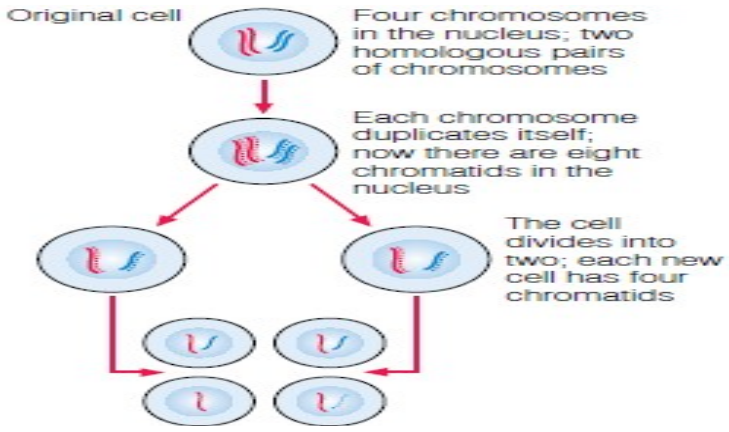
2) **Metaphase II**: new spindles are formed and the chromosomes, still made up of pairs of sister chromatids, line up on the metaphase plate

3) **Anaphase II** –the centromeres now divide and the sister chromatids move to the opposite ends of the cell

4) **Telophase II** : Nuclear envelopes reform, the chromosomes return to their interphase state,

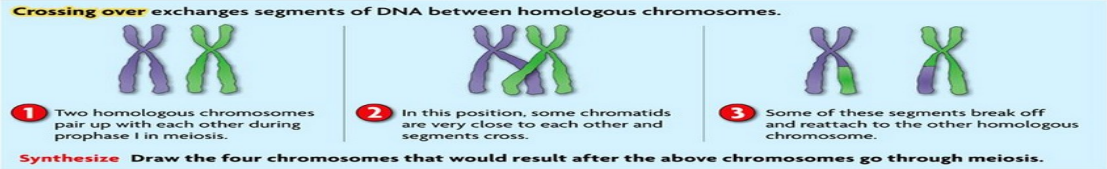
- ❖ **Cytokinesis** occurs, giving four daughter cells each with half the 2n chromosome number of the original diploid cell





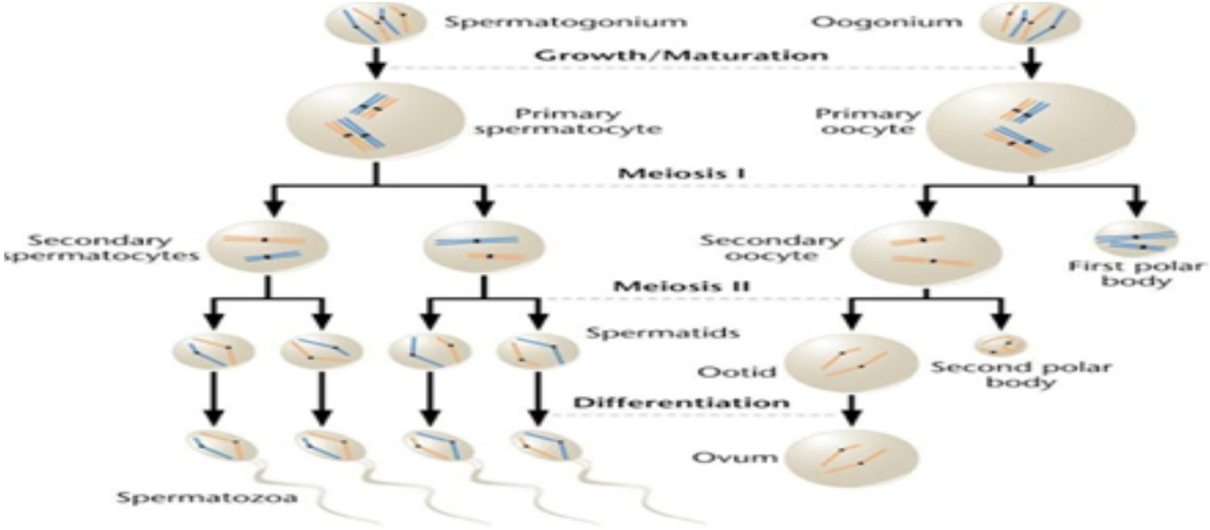
B. Crossing over during meiosis increases genetic diversity

1. **crossing over** – exchange of chromosome segments between homologous chromosomes during Prophase I of Meiosis I
2. Results in **new combination of genes**



Gametogenesis (Gamete formation: production of male and female gametes

- Is the process of production of gametes from diploid germ line cells.



- **Oogenesis (egg formation):** occur in ovaries of females
  - Takes place in ovaries
  - The first stage of meiosis is completed before birth.
  - Baby girl contain all the ova she will ever have
  - The second meiotic division occur during puberty
  - Only one large ova(egg) produce per cycle
  - **Oogenesis** Stops at menopause
- **Spermatogenesis (sperm formation):** occur in taste of males
  - The production of sperm
  - Takes place in testes

- In males, meiosis doesn't start until puberty,
- Carries throughout a man's life.
- 4 spermatid (sperm) produce per cycle
- Each gametes genetically different

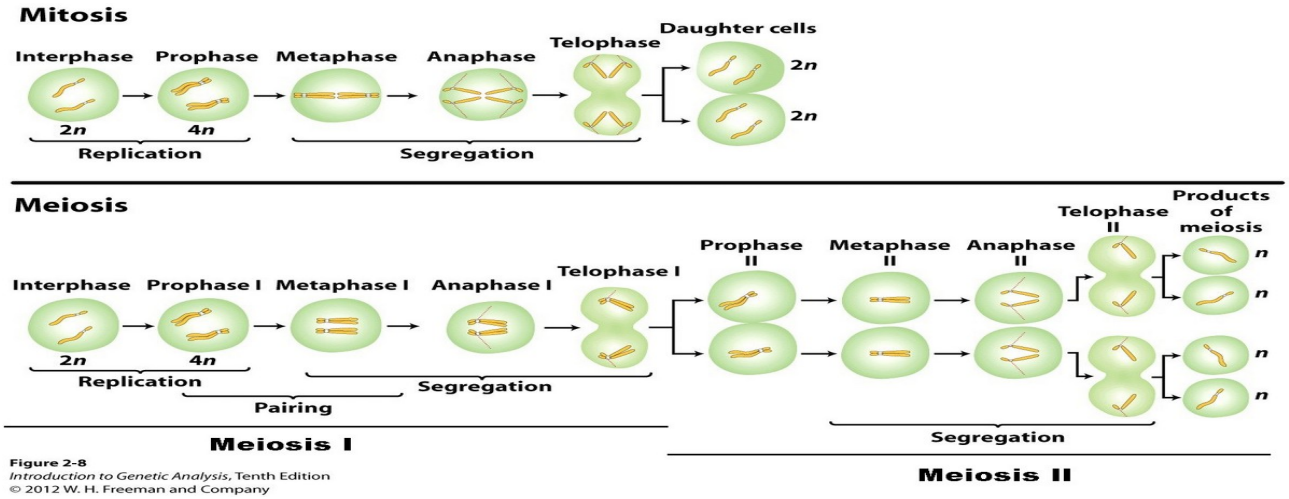


Figure 2-8
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Table Comparison of mitosis and meiosis

MITOSIS	MEIOSIS
❖ Take place in somatic cell	❖ Take place in germ (sex) sell
❖ Occur in both sexually and asexually reproduction organism, equal division	❖ Occur only in sexually reproduction organism, reduction division
❖ One division, diploid cells (2n)	❖ Two division, haploid cells (n)
❖ Important in cellular reproduction, growth and repair of body cell	❖ Important in genetic diversity through sexual reproduction
❖ Makes every cell other than sex cell	❖ Makes sex cell, sperm and egg
❖ 2 daughter cell produced	❖ 4 daughter cell produced
❖ Daughter cell genetically identical	❖ Daughter cell genetically d/t b/c of crossing over
❖ Chromosome number the same as the parent	❖ Chromosome number reduce by half of original
❖ No pairing of homologous chromosome	❖ Pairing of homologous chromosome

Exercise

1. If a cell with 12 pair of chromosomes undergo mitosis

a) How many cell will be produced

b) How many chromosomes will each cell have

Review questions

1) Chromosomes are made up of:

A. RNA B. protein C. DNA D. acetic orcein

2) How many chromosomes would you expect to find in a normal human body cell?

A. 23 B. 50 C. 84 D. 46

3) Which combination of chromosomes would result in a human male?

A. XXX B. XY C. XX D. YY

4) Which of the following statements is not true of mitosis?

A. Initial stages of cell division, the chromosomes divide to form daughter chromatids.

B. Mitosis is used to replace old, worn-out cells.

C. Two identical daughter cells, known as clones, are formed.

D. Genetic variety is introduced during the process.

5) Which of the following statements is true of meiosis?

A. Genetic variety is introduced during the process.

B. Meiosis is used to replace old, worn-out cells.

C. Two identical daughter cells, known as clones, are formed.

D. Meiosis is involved in asexual reproduction.

Mendelian inheritance

Before Mendel--Blending inheritance

- Inheritance of traits from two parents produces offspring with the characteristics that are intermediates between those parents
- the characteristics of the parents blended together so that the distinct characteristics of each parent were lost
- E.g. a cross between a black dog and a white dog would give grey puppies

Gregor Mendel discoveries

- The father of genetics



- The first person who tried to explain the **pattern of inheritance of trait** experimentally on garden pea (Pisum sativum)
- He did not know about genes or DNA
- Mendel chose garden pea for his experiment, for the following reason
  - Pea have self-pollinating flower that can be easily controlled
  - Easy to cultivate
  - Pea have many contrasting traits
  - Cross pollination and fertilization can easily be achieved
- Mendel used 14 varieties of garden peas, w/c he grouped into 7 pair of contrasting traits listed below

Specific traits	Pure Dominant x pure recessive	F1 product
Stem length	Tall x Short	Tall
Pod color	Green x Yellow	Green
Pod shape	Inflated x Constricted	Inflated
Seed shape	Round x Wrinkled	Round
Seed color	Yellow x Green	Yellow
Flower position	Axial x Terminal	Axial
Flower colour	Purple x white	Purple

Important terms

- **Alleles:** different forms of the same gene
- **Homozygous:** has the same allele of gene on each of the chromosomes in the homologous pair .E.g. TT, tt
- **Heterozygous**: has different allele of gene on each of the chromosomes in the homologous pair. E.g. Tt, Yy
- **Punnet square:** is the genetic crosses that can be shown with the use of simple genetic diagram.
- **Hybrid:** is an organism produced from parents with contrasting traits.

- **Monohybrid:** a hybrid b/n two parents that have a difference of only one gene.
- **Gene (factor):** is a part of DNA that contains information about a particular protein.
- **Genotype**:
  - Combination of alleles of an organism
  - Describes the genetic makeup of an individual
  - Describes the pair of alleles for a particular gene. E.g. TT, Tt, Yy
- **Phenotype**:
  - Describe their physical trait/appearance
  - describes traits determined by a particular **genotype.** E.g. tall, short, yellow etc.
- **Dominant allele** is the allele expressed in a heterozygous organism
  - An allele w/c is expressed
  - An allele expressed in the phenotype even if only one copy of the allele is present. Always represented by capital latter. Tall (T), yellow seed (Y)
- **Recessive alleles** is an allele only expressed in a homozygous organism
  - An allele w/c is masked/ not expressed
  - An allele expressed in the phenotype only if two copies of the allele are present.
  - represented by small later short plant(t),green seed (y)

Mendel experiment on monohybrid inheritance

- **monohybrid inheritance** is inheritance of a single pair of contrasting traits
  - **First** Mendel produce pure breeding or **true breeding plant**
    - **Pure breeding or true breeding** plant is the one that produce offspring through self-pollination and always resembles their parents for the given traits

- For example, a pure plant that is true breeding for tallness would always produce a tall pea plants upon self-pollination and self-fertilization

❖ **Second** removing male part or emasculation and artificially cross pollination for each pair of contrasting traits. For example;

- Pure breeding tall plants (TT) cross with a pure breeding short plant (tt). He called **P_1 generation.**
- The offspring or the resulting from P_1 generation is called **first filial generation (F_1)**, all become tall plant (Tt) or dominant traits.

❖ Mendel allowed F_1 plant to self-pollinate in the next season and produce second **filial generation or F_2**, ($F_1 \times F_1$ F_2)

- The offspring produced three quarter dominant ($^3/_4$) and one quarter recessive ($^1/_4$), the ratio 3:1
- The trait expressed itself in F_1 generation, is dominant. Whereas the trait masked or hidden in F_1 generation is recessive

☝ **Example T=**tall allele, **t=** recessive allele

Parent (P_1): pure tall × pure short

Genotype: **TT** × **tt**

Genotype: **T** and **T** **t** and **t**

X	**T**	**T**
T	T t	Tt
T	T t	Tt

F_1 product phenotype all tall

Genotype hybrid tall (Tt

If two F1 offspring self-pollinate, we get the following results ($F_1 \times F_1$)

F1 parent phenotype: hybrid tall hybrid tall

Genotype Tt Tt

Gametes **T** and **t** **T** and t

	T	**T**
T	TT	Tt
T	Tt	tt

F2 product phenotype: 3 tall 1short (phenotype ratio3:1)

Genotype: **1**pure tall (TT): **2** hybrid tall (Tt): **1** short (tt) or (1:2:1)

Mendel conclusion from his discovery

- Heredity determined by **factors** which today called **gene**
- Each trait determine by a pair of factors
- One factor comes from each parent
- The alleles are not paired in gametes
- During fertilization the allele paired again

Mendel develop two important low

- **The law of segregation;**
  - Factor separate during gamete formation
  - A pair of factors are not included in the same gamete
  - Gamete contain only one factor
- **The law of independent assortment**;
  - Factors belonging to d/t traits segregate independently during gamete formation.
  - The traits transmitted to offspring independently of one another
  - Example the inheritance of tall plant seed is independent of yellow color seed

Test cross

- A breeding experiment important to determine the genotype of an organism with a dominate phenotype
- The organism is crossed a homozygous recessive organism
- If all of the offspring shows a dominate phenotype the organism is homozygous dominant

- **If a homozygous yellow parent is crossed:**

Parental phenotype	yellow	x	Green
Parental genotype	YY	x	yy
Gametes	Y and Y		y and y

	Y	**Y**
y	Yy	Yy
y	Yy	Yy

Offspring genotype (F1 generation) Yy

Offspring phenotype all yellow seed

If a heterozygous yellow parent is crossed:

Parental phenotype yellow x Green

Parental genotype Yy x yy

Gametes Y and y y and y

	Y	**y**
Y	Yy	yy
Y	Yy	yy

Offspring genotype (F1 generation) Yy: yy

Offspring phenotype 1 yellow: 1 green

Type of dominance

1. **Complete dominance**:
   - one pair of allele in a heterozygote completely masks expressions of other**.**
   - **E.g.** tallness dominant over shortness
2. **Incomplete dominance:**
   - there is a dominance but not expressed in full extent ,the heterozygote show somewhat intermediates between the two parents
   - **E.g Red x white** produce **pink**
3. **Coodominant:** No dominant and recessive relationship
   - In heterozygous organism each allele of a gene produces their gene product equally on the offspring. E.g. **cattle fur color, ABO blood group**

A. Phenotype of cattle fur color: Red bull (RR) x White cow (rr) = roan (Rr)

B. ABO blood group of human

- Human blood type is controlled by A, B and O alleles
- Allele A and B are codominant



- Allele O is recessive

PHENOTYPE	GENOTYPE
Type A	AA,AO
Type **B**	BB, BO
Type AB	AB
Type O	O

☝ **Example**

1. Suppose a man with blood type O marries a woman a women with blood type B. what would be the blood group of the child?

   Answer. Man; Phenotype type O, Genotype OO

   Women; phenotype Type B, Genotype BB,BO

Man

	O	**O**
B	**BO**	**BO**
B	**BO**	**BO**

Women

Man

	O	**O**
B	**BO**	**BO**
O	**OO**	**OO**

Woman

- Genotype of children would be BO and OO
- Phenotype of children would be; type O. type B

2. A woman with blood type AB Maries a man with blood type O. What blood type might the children have

- **Phenotype women type AB, genotype AB**
- **Genotype of man type O, genotype OO**

Woman

Man

	A	**B**
O	**AO**	**BO**
O	**AO**	**BO**

The children have blood type A, type B

Exercise

1. If two people have AB blood type marry. What blood group the children have.
2. What are three alleles that form the gene for ABO blood group are?

Mendelian genetics in people

- Mendel mechanism of inheritance work for all organism including all organism
- There are ten thousands of traits that can be determining the gene of human.
- Some of these inherited trait are

TRAITS	**DOMINANT**	**RECESSIVE**
❖ Dimpleness	❖ Dimple	❖ No dimple
❖ Ear lobe	❖ Dangly	❖ Attached
❖ Thumb	❖ Straight	❖ Curved
❖ Tongue rolling	❖ Roller	❖ Non-roller
❖ Handedness	❖ Right hand	❖ Left hand
❖ Albinism	❖ Normal	❖ Albino

Example

1. **Dimpleness** dimple, D
   No dimple**, d**

☝ **Father no dimple mother hybrid dimple. What about children?**

Answer. Father; Phenotype no dimple, Genotype dd
Mother; phenotype dimple, Genotype Dd

Mother

	D	**D**
D	**Dd**	**Dd**
D	**Dd**	**Dd**

Father

- genotype of children: 2 hybrid dimple Dd and 2 non dimple dd
- phenotype of children: 2 hybrid dimple,2no dimple (1;1 ratio)

☝ **Exercise;** how many % of children have dimple?

A. both couple hybrid dimple
B. father dimple and mother non-dimple

2. **Ear lobe;** dangly, E
   Attached, e

☝ If both of the couple have hybrid dangly ear lobe, How many % of children have dandily

Answer. Father; Phenotype no dimple, Genotype Ee
Mother; phenotype dimple, Genotype Ee

Father

	E	**E**
E	**EE**	**Ee**
E	**Ee**	**Ee**

Mother

- Genotype of children:1 dangly EE, hybrid dangly 2Ee & 1 attached ee(genotype 1:2:1ratio)
- phenotype of children: 3 dangly ear lobe, 1 attached ear lobe (3;1 ratio)
- Therefore 75% of the children have dangly ear lobe(50%hybrid,Ee and 25%pure dangly)

3. Albinism

- Albinism is a humans genetic disorder characterized by absence of melanin pigment in skin ,hair and nail
- Results from a recessive gene
- A person with a complete loss of melanin pigment is called **albino**
- Albinism is an inherited disorder. Children have a risk of albinism if;
  - They have parents with albinism
  - Parents who carry the gene for albinism

Example normal, A
Albino, a

Genotype	Phenotype
AA	Normal
Aa	Normal carry an albino gene(carrier)
Aa	Albino

- **How two carriers can produce an albino child?**

Answer. Phenotype of the parent's normal carrier, Genotype Ee
Genotype of the parents Aa

Father

	A	**A**
A	**AA**	**Aa**
A	**Aa**	**Aa**

Mother

- Genotype of children 1pure normal AA, 2hybrid normal Aa and 1albino aa (genotype 1:2:1ratio)
- phenotype of children 3 normal, 1albino (3:1 ratio)
- Therefore 75% of the normal but 25%of albino child
- Albino individuals vulnerable to;
  - Skin cancer
  - Their eyes are sensitive to light (problems with their vision)

- **Exercise** how many % of the child is an albino

1. Father heterozygous normal and mother an albino
2. Mother pure normal and mother an albino
3. Demissie is albino but Seble is not. They are expecting a baby.
   a) What is Demissie's alleles are how do you know?
   b) If the baby has normal colouring, what does Seble's possible genotype?
   c) If the baby is albino, what does Seble's possible genotype
4. The allele for straight thumbs is dominant to the allele for curved thumbs. Draw a genetic cross between:

a) Two heterozygotes

b) heterozygote and a homozygous recessive individual

Review questions

1) The basic unit of inheritance is:

A. DNA B. a chromosome C. the nucleus D. a gene

2) Bekele has dangly earlobes. He has inherited one allele for dangly lobes from his mother and one for attached lobes from his father. Which of the following terms best describes Bekele's genotype for his earlobes?

A. homozygous B. heterozygous C. homologous D. autosomal

3) Which of the following statements is a definition of a recessive allele?

A. An allele that controls the development of a characteristic even when it is only present on one of your chromosomes.

B. An allele that controls the development of characteristics alongside another different allele that is also expressed in the phenotype.

C. An allele that only controls the development of a characteristic if it is present on both chromosomes.

D. An allele that only occurs on the sex chromosomes.

4) Which of the following conditions is inherited?

A. TB B. albinism C. anaemia D. HIV/AIDS

Worksheet

5) In human dangly earlobe is due to dominant gene (D) and attached earlobe is due to a recessive gene (d). If the mother is Dd and the father is dd, what proportion of their children would be expected to be dangly earlobe?

a) 75% B.50% C.25% D.100%

Heredity and breeding

Breeding

- is the process of genetic modification of plant and animals
- is largely important in breeding of farm animals and crops

☝ **Selective breeding**

❖ is a technique of breeding crop plant and animal with desirable trait.



- is used to breed for particular traits.
- It should be select true-breeding plants or animals, for doing this
  - It is important to know the history of the organism.
  - If the characteristic you want to select for is recessive, it is easy to be sure that the parents are true breeding because they will be homozygous.
  - If the trait you want is dominant, it need to carry out a test cross using a known homozygous recessive on the parents to make sure they are homozygous.
- In selective breeding plant and animals the best characteristics you want should be allowed to mate, but animals which do not have the characteristic should be castrated or prevented from mating
- In selective breeding also need to avoid the animals becoming **too inbred**
- **In breeding:** is breeding of two close relatives can eventually lead to genetic weakness.
- E.g; **Belgian Blue** (bred purely for meat) and a **Holstein Friesian**, bred purely for milk.

☝ **Cross-breeding -combination of traits**

- It is a technique of breeding crop plant and animal is to combine good traits from two different breeds. E.g;.
  - A family's herd of goats w/c give good milk yields but do not cope well without shade
  - Another family's goat which **give less milk** but are very hardy and **resistant to the heat** of the sun.
  - If both families selected their best male and female goats, and cross- bred,
  - The offspring would inherit both the genes for **good milk production** and the genes for **heat resistance**.
- Farmers often simply continue to cross-breed to get the benefits of each F1 generation.

- **Importance of breeding for society**

Selective breeding to maintain

- To create the best possible performance in our local breeds
- They will get the best possible yield from their crops,
- The most milk from their cows, sheep, goats or camels,

By cross-breeding --combining useful traits;

- **A** good temperament with a fast growth rate, or
- A better milk yield with an ability to thrive on poor forage,
- Can create new breeds even better suited to the different areas of our country.
- The more food we can produce, the stronger and healthier both we and our children.
- As a source of new genetic material to help overcome changes in the world climate

Review questions

1) Which of the following is not an Ethiopian breed of cattle?
   A. Borena B. Zebu C. Holstein Friesian D. Raya
2) Cross-breeding is also known as:
   A. selective breeding B genetic engineering C horticulture D combination of traits
3) Selective breeding involves:
   A. choosing a weak characteristic and selecting for it
   B. choosing a strong characteristic and selecting for it
   C. mating your animals with a different breed
   D. none of the above
4) Which of the following is NOT true of crossbreeding?
   A. The offspring immediately form a new breed of animal or plant.
   B. The offspring are the F1 generation.
   C. The offspring do not breed true.
   D. The offspring may combine the best traits of both breeds.

WORK SHEET (HEREDITY)

1. In somatic cell cycle, DNA replication takes place in;
   A. Interphase C. Prophase C. Metaphase D. Telophase
2. How many mitotic divisions are needed for a single cell to make 128 cells?
   A. 8 C.9 C. 6 D. 7
3. The 'rungs' of DNA ladder made of;
   A. Phosphates and bases C. Bases C. Sugar D. Sugar and phosphate
4. If a cell with 12 chromosomes undergo mitotic division and produced two daughter cells, how many chromosomes will each cell have?
   A. 6 C.12 C. 4 D.24
5. What stage of meiosis where sister chromatids moves to the opposite pole?
   A. Anaphase I C. prophase I C. Anaphase II D. Metaphase II
6. What is mitosis? it is
   A. Formation of sex cell C. Formation of zygote
   B. Copying of chromosomes D. Division of somatic cell
7. The main objective of Gregor Mendel's work was to proof how
   A. Cell division works C. Inheritance work
   B. Breathing system work D. Blood circulation work
8. When Mendel crossed pure round pea flower with pure wrinkled pea the offspring at F_1 generation will be?
   A. All Wrinkled C. All round
   B. 1 Wrinkled 3 Round D. 2 Wrinkled 2 Round
9. Which of the following outcomes was correct in a crossing of a yellow seed (Yy) an green seed(yy) pea plant?
   A. Three yellow and one green seed, phenotypically
   B. All of the outcomes were yellow, genotypically
   C. All outcomes were green, genotypically
   D. Two yellow and two green seed, Genotypically
10. What is meiosis? It is division of
    A. haploid cell B. sex cell C. blood cell D. brain cell
11. An allele for dangly earlobes (D) is dominant over attached ear lobes, A women with dangly ear lobes is married to a man with attached ear lobes. Which of the following shows the possible genotype of their offspring?

A. .DD B. DD and Dd C. DD and dd D. Dd and dd

4) In the process of mitotic cell division, what will happen during anaphase stages?
   A. spindle fiber pull chromatid to opposite pole
   B. two new nuclei form at the poles of the cell
   C. chromatid line up in the equatorial of a cell
   D. chromosomes are copied as DNA replicates
5) During **meiosis I** which phase does each chromosome appear condensed form with two chromatid?
   A. telophase I C. Metaphase I C. prophase I D. anaphase I
6) Which of the following is a correct pairing of nitrogenous base in DNA?
   A. Cytosine- Guanine C. Adenine- Guanine
   B. Thymine-Guanine D. Thymine-cytosine
7) What do genetics call the genotype in which the two alleles of a pair are identical?
   A. Dominant B. recessive C. homozygous D. Heterozygote
8) Which of the following chromosomal composition result in human male?
   A. XX C. XO C. XXX D. XY

1. Which stage of mitosis do sister chromatid line up along equatorial plane
   A. Telophase C. Prophase C. Metaphase D. Anaphase
2. If a cell have 2n=40 chromosomes divides mitotically and produce four daughter cells, how many chromosomes will each daughter cell?
   A. 40 B. 20 C. 10 D.80
3. During which stages of meiosis do member of homologous chromosomes separate
   A. Prophase I B. Anaphase I C. Metaphase I D. Telophase I
4. A tall plant with Tt genotype is test crossed, what would be the expected result?
   A. all of the offspring will be tall C. 75%tall and 25% short
   B. 50% tall and 50%short D. 25% tall and 75% short
5. Suppose a lost and found baby is claimed by four families whose blood genotype is shown below. If the baby blood type is "O" which family is the possible parents
   A. AO and BB B. AA and OO C. AO and BO D. AB and OO
6. As shown in Gregor Mendel garden pea, what % of the F_2 generation of monohybrid cross has a dominant phenotype?

A.100 B.75 C.25
D.0

7. Among the following one is **not** produced in mendel monohybrid cross in F_1 generation?
   A. Tall plant B. White flower C. Round seed D. Axial flower
8. Suppose 800 pea plant produced from Tt and Tt cross. How many to be short?
   A. 600 B.400 C. 200
   D.800
9. A married couple had three boys in a row, what is the chance of the next child would be a girl?
   A.25 B.50 C.75
   D.100
10. An organism has 24 chromosomes in their normal body cell is mated with another organism having 24 chromosomes. The number of chromosomes of the resulting offspring will be?
    A.48 B.12 C.24 D.46
11. A genetic cross having a hybrid yellow seed, what % of a green seed produced in F_2 generation?
    A.100 B.0 C.75
    D.25
12. How many chromosomes do human inherits from each of their parents?
    A. 46 B.23 pair C.46 pair D. 23

1) The cross between two tall plants give you only tall plants, which of the following conclusions can you arrive at? Tallness is dominant
   A. Shortness is dominant over tallness
   B. Both parent were hybrid tall
   C. The parent were pure for tallness
   D. All
2) How is one DNA differing from another DNA? This is because
   A. DNA molecule is capable of replication
   B. the number, type and sequence of bases
   C. they contain a number of gene
   D. DNA molecule separates during meiosis
3) Which of the following statements true about DNA and RNA
   A. Both composed of sugar, phosphate and bases
   B. Both are equally important in determining traits
   C. Both exist as a single chain nucleotide
   D. Both are capable of replication

4) Which of the following character can be considered as having been controlled by allelic gene in pea plant?
   A. smooth seed and yellow seed coat C. pinch and terminal flower
   B. smooth seed and wrinkled seed D. short and green cotyledon
5) if one imagines the DNA molecule a tiny ' ladder' the cross bar of the ladder are made up of
   A. sugar and phosphate B. sugar C. bases D. phosphate and bases
6) The 2n chromosome number of a horse is 64 the number of horse chromosomes in each body cell of a mule is
   A. 64 C.128 C. 32 D. 8
7) When a cell having 12 chromosomes divided by mitosis , each of the daughter cell would receives
   A. .6 B.12 C. 24 D.4
8) The fact that DNA is the genetic material located on chromosomes and not the proteinaceous histones was proved by the following evidence
   A. Only change in composition of DNA result in a change of the characteristics individual
   B. Certain external factor (ultra violet ray) change the x-r of both DNA and individual but not histone
   C. Only DNA double in quality before every cell division
   D. All
9) Phenotypic variation
   A. Is affected by the environment
   B. Can always be passed on the offspring
   C. Can be passed to the offspring only if caused by adaptation
   D. All
10) If two phenotypically tall plants are crossed, the first generation of plants will always be
   A. All phenotypically tall
   B. One-fourth will be short
   C. All phenotypically and genotypically tall
   D. None
11) If one crosses phenotypically tall pea plants and all the off springs are tall, the parents
   A. Both could be homozygous
   B. both could only be homozygous
   C. One could be heterozygous
   D. Both could only be heterozygous
   E. .A and B

12) If one of the two chain of DNA molecules has ACGT bases the corresponding bases on the other chain are
A. TGCA C.AGCA C. TGCT D. TGCA

13) Which of the following is correct regarding the number of Adenine, guanine, thymine and cytosine in a DNA molecule
A. G=A C. T=C C. A+C=C+T D. G+A=C+T

14) If in a DNA molecule cytosine makes 20% what is the percentage of cytosine?
A.20% B.80% C.60% D.30

15) The complete set of chromosomes that we inherit from one of our parent is referred to as
A. diploid B. haploid C. homozygous D. polyploidy

16) A single cell of testis divide to produce
A. A single sperm C. 2 sperm C. 6 sperm D. 4 sperm

17) In which of the following crosses would one expect more than one phenotype assuming that 'B' is dominant to' b'
A.BB and bb B.BB and Bb C. bb and bb D. Bb and Bb

18) Assuming 'A' is dominant over 'a' which one of the following phenotypic ratio is expected from Aa and Aa cross
A. 2:2 B.3:1 C.2:1 D.4: 0

19) What is the number of chromosomes in a human fertilized egg?
A.23 B. 23 pair C.46 D. 46 pair

20) In a human. Albinism is determined by a recessive gene. Have if two parents have produced a legitimate child who is an albino. The child has most likely inherited the defect from
A. Both parents C. The mother only
B. Either mother or father only D. The father only

21) Kebede is left handed his parent are both right handed. If right handedness (R) is dominant over left handedness(r) what were the genotype of the parents?
A.RR and rr B. RR and RR C. Rr and Rr D.RR and Rr

9) Which of the following is considered as the importance of breeding to society? it is used to
A. Reduce use of natural resource C. Reduce genetic diversity
B. Produce sufficient food D. avoid new gene production

10) The process of combing good traits from different breed is;
A. Cross breeding C. association breeding
B. test cross D. selective breeding

11) A type of breeding done to produce a particular traits;

A. multiple breeding C. Cross breeding C. true breeding D. selective breeding

12) production of biogas is an application of biotechnology in the area of
A. Energy C. water C. food D. medicine

Unit 3: Human Biology and Health

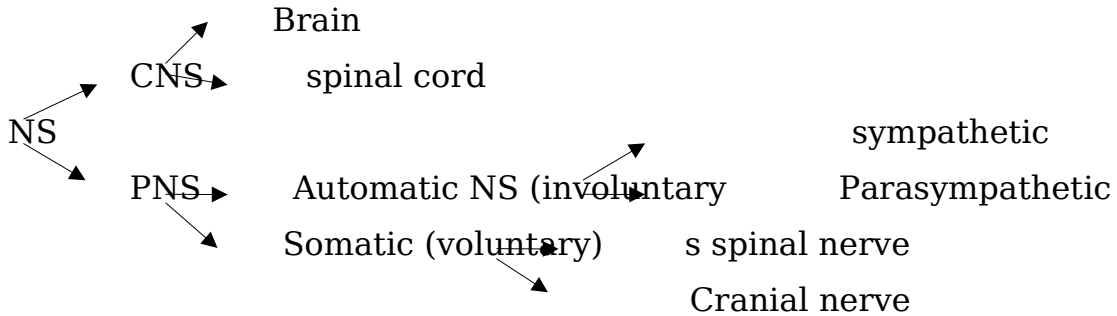
3.1 The nervous system

There are two different systems that have a role in co- ordination and control of the body.

Nervous system	**Endocrine (hormonal) system**
❖ electrical & chemical (neurotransmitter) coordination	❖ It is chemical (hormonal) coordination
❖ Messages travel fast through nerve cell	❖ Hormone transported through blood
❖ Messages usually have rapid effect/response as telephone system	❖ Provide a slower response as postal system except adrenaline.
❖ Origin of message are receptors	❖ Origin of message are endocrine gland
❖ Destination of message are effector	❖ Destination of message are target cell

Nervous system: made up of neurons w/c transmit electrochemical impulses around the body.

Endocrine system: consists of ductless glands w/c coordinate the activities of organism by secreting hormone.



- **The nervous system has two main systems**.
  - **The central nervous system (CNS)** is made up of brain and spinal cord.
  - **The peripheral (body) nervous system (PNS)** is made up of the neurons (nerve cells) and the sensory receptors.
- Have two nerves that connect CNS to all part of the body. These are;
  - **Cranial nerves** the nerves that come out of the brain. They go mainly head and neck, like your eyes, tongue and jaws
  - **Spinal nerves** the nerves come out of the spinal cord**.** They go to the arms, the legs and the trunk
- **For nervous coordination three things are necessary**
  - **Sensory receptors** - nerve endings that can sense stimuli, e.g. pressure, pain, temperature
  - **Coordinator** –brain and spinal cord
  - **Effectors**- muscle and gland

Neurons (**nerve cell**):

- Is the basic unit of nervous system, it contains 3 parts;

1) Cell body: contains the cell nucleus, mitochondria, and other organelles.

- Receive messages from dendrites

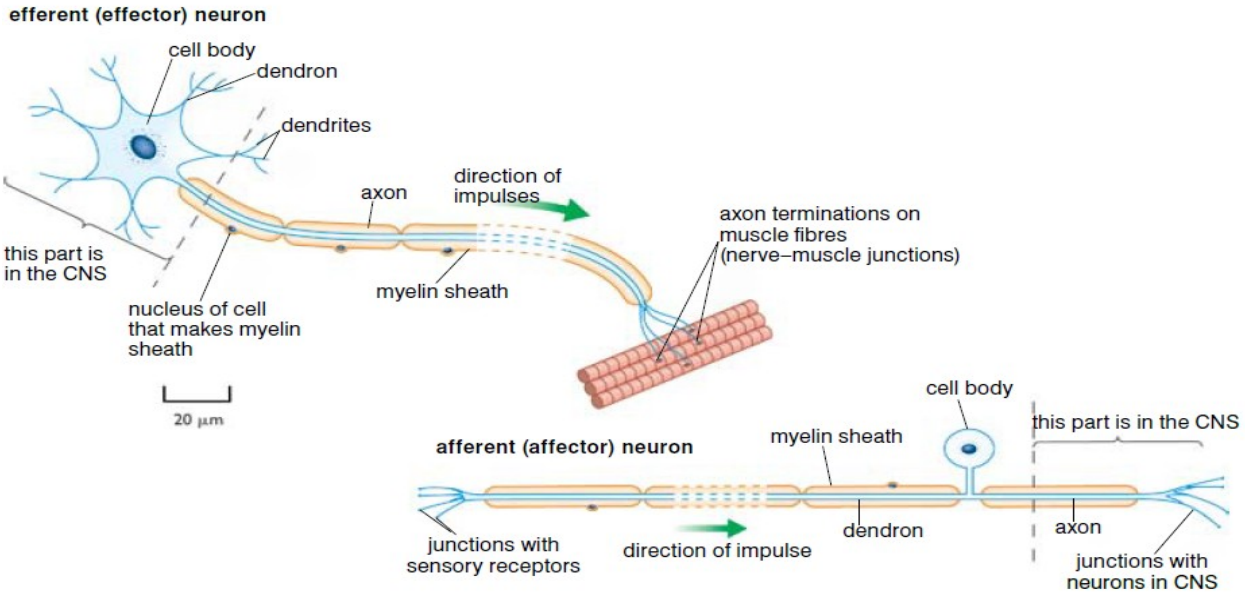
2) Dendrites: slender finger-like projection

- receive impulse from another neuron and conduct to cell body
- join one neuron with other neuron

3) Axon (nerve fibre)

- Extremely long and thin carry nerve impulses away from cell body.
- axon membrane changes its permeability to sodium ions to create an electrical impulse
- Covered by fatty substance called **Myelin sheath.**

❖ **Myelin sheath** provides a layer of insulating material so the nerve impulse travels as fast as possible.



- **Synapse** is the junction (gap) between neurons or neuron and muscle fiber.
  - Neurons are not continuous 'wires' running about your body.
  - Whenever one neuron ends and another begins there is a gap known as a **synapse**.
  - The electrical impulses that travel along your neurons have to cross these synapses, but an electrical impulse cannot leap the gap. So when an impulse arrives at the end of a neuron, chemicals are released.
  - These chemical transmitters (**neurotransmitters**) cross the synapse and are picked up by special receptor cells in the end of the next neuron.
  - In turn this starts up an electrical impulse, which then travels along your next neuron..
  - two type;
  - **Neuron-neuron junction** is the junction between two neurons (axon-to-dendrite)
  - **neuromuscular junctions** is the junction between an axon terminal of a motor neuron and a muscle fiber

☝ **Neurotransmitter**

- The electrical impulses cannot jump **synapse** or the gap.
- An impulse transmits across the synapse by means of chemical transmission called neurotransmitters.
- The neurotransmitter can be inhibitory or excitatory chemical.
- For example acetylcholine has excitatory effect on skeletal muscle but inhibitory effect on cardiac muscle.
- A number of well-known poisons work by affecting synapses with acetylcholine
  - **Botulinus toxin** affects the first membrane and stops the release of acetylcholine. No transmission of impulses across synapses prevents the nervous system from working and causes death.
  - **Strychnine and organophosphorus** compounds deactivate the enzymes on the second membrane and so prevent the breakdown of acetylcholine.
  - The muscles contract all the time causing rigid paralysis.
  - **Curare** stops the second membrane from responding to the chemical transmitter. This causes paralysis as the muscles can no longer be stimulated by the nerves
  - **Mental illness:**
  - Refers to psychological, emotional or behavioral disorder
  - can be the result of an imbalance of the chemical transmitters in your brain,

Type of neuron

1) Affector/Afferent/Sensory neuron

- carry impulses from receptor to CNS (spinal cord & brain)
- cell body are located in the spinal ganglia of dorsal root of spinal cord

2) Effector/Efferent/Motor neuron

- Carry impulses from the brain and spinal cord to the effectors organs (muscles & gland)

- Cell body of motor neuron found in the grey matter of spinal cord.

3) Relay (Association or inter neuron)

- Found in central nerve system
- Connect sensory and motor neuron
- Transfer incoming neuron from sensory to motor neuron

Receptor S.N **CNS** M.N **effector**

Receptor: site of stimulus/sense organ. E.g., skin, ear, eye, e.t.c .

Effector: site of response. E.g., muscle and gland

The pathway of an impulse during nerve coordination

- Sense organ →afferent neuron→ CNS → efferent neurons → muscles or a gland.

- **Nerves** are bundles of neuron fiber.

Nerve impulse transmission

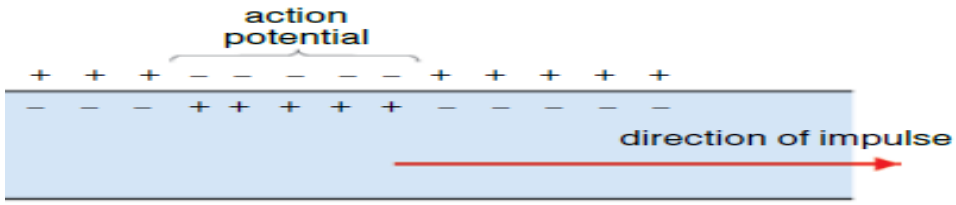
- An electrical message that move from one part of the neuron to others
- Is electrical events that result of charge difference across the membrane of the axon.
- Each nerve impulse is a minute electrical event that is the result of charge differences across the membrane of the axon.

Resting/polarized potential:

- Is a potential across the membrane is at rest (no conducting impulse)
- During resting potential, the outside of the membrane of the neuron carries positive & inside negative.

Action potential/depolarization:

- Is the wave of positive charge inside the axon when the neuron is stimulated.
- When impulse transmit, the positive charge comes inside and the negative charge comes out side**.**



Central nervous systems: the brain and the spinal cord

1. The Brain

- Human brain is the complex structure b/c it contains hundreds of thousands of millions of neurons.
- Brain is enclosed in membranes and protected by the bones of **skull (cranium)** and **meanings,** a membrane that surround the brain
- Each side of your body is controlled by the opposite side of your brain
  - The left-hand side of brain is good at processing information and largely controls speech and information processing
  - While the right- hand side is better at special awareness and recognizing faces.
  - If the right-hand side of your brain is damaged you may be unable to recognize even your closest family.

☝ **Cross section of the brain**.

- **Grey matter**: bulk of the brain– cell bodies of neurons & synapses that connect them.
- **white matter** is Inside the brain -the axons that lead into and out of the brain

☝ **Parts of the brain**

a) The fore brain consists

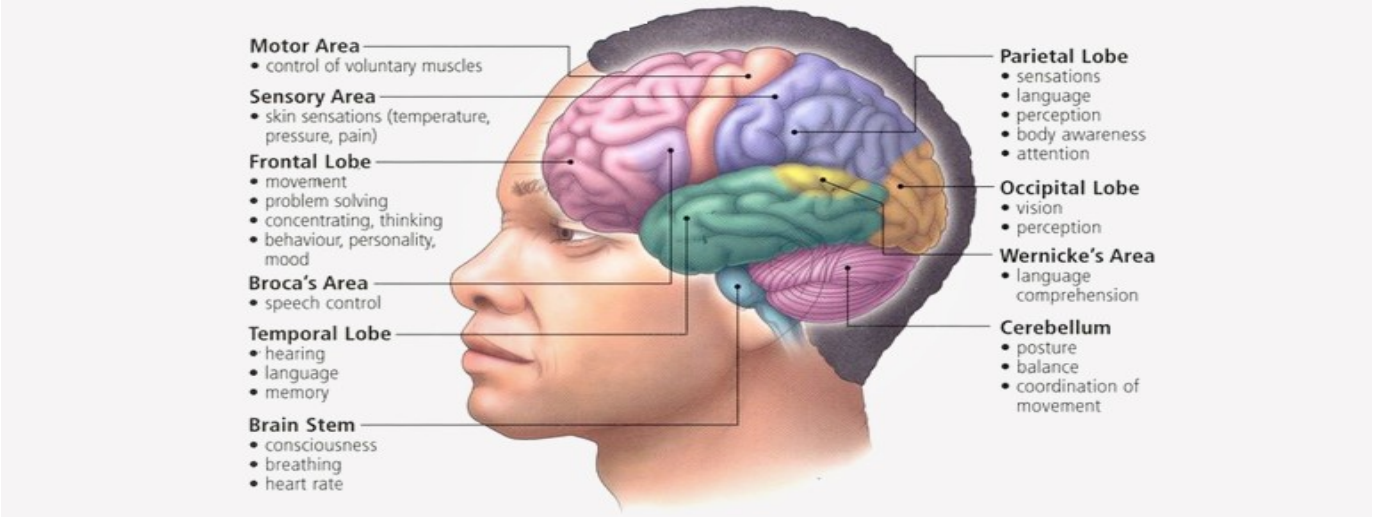
- **The cerebral hemispheres**
  - involved in speech, intelligence, thought, memory and learning
  - dealing with coordination of sensory and motor function
- **Hypothalamus** regulation of temperature, hunger, thirst, sleep, emotion and reproductive behavior

b) The mid brain: deal with vision (the optic lobes), auditory lobes and communication centre.

c) Hind brain consists;

- **cerebellum** deal with balance and orientation

- **medulla** regulate respiration, breathing, circulation and salivation



2. The spinal cord

- a tube structure w/c extends down ward from the brain stem to pelvis.
- protected by the vertebral column

The cross section of spinal cord

- The **grey matter** are in the middle
  - Contain cell bodies and short relay neurons
- The **white matter** is on the outside.

Root of spinal cord

- dorsal root at the back of the spinal cord
  - sensory impulse through afferent neuron enter the cord
  - contain sensory (affector) neuron
- ventral root at the front of the spinal cord
  - impulse that travels from CNS to the effectors organ starts
  - contain motor (effector) neuron

Function of spinal cord

- It serves as a center of reflex action
- It serve as the pathway of motor impulse from the brain to various part of the body and also sensory impulse from various part of the body to brain



Voluntary action:

- Conscious response to stimulus is under the voluntary control of the brain
- Able to use your senses and mental powers to understand what is happening.
- In a normal conscious action we are in control – we see a book, reach out and pick it up or hear an approaching car and stop moving.

Reflex action (involuntary action)

- Is sudden, automatic, and uncontrolled response part of the body or the whole body to external stimuli
- Is unconscious effort/do not use brain.
- a means of protection and homeostatic reaction automatically
- **Reflx arc** is the neural pathway during reflex. It involves;
- Stimulus ▸ receptor ▸ afferent neuron ▸ coordinator ▸ efferent neuron ▸ effector (muscle and gland) response

There are two type of reflex action

a) Simple reflex action

b) Conditioned reflex action

1) Simple reflex action

- A very rapid, involuntary, automatic response to stimuli
- Is unlearned to stimuli/ it born with us. E.g;
  - knee-jerk reflex
  - withdrawal from heat
  - blinking of the eye
  - sneezing , coughing

2) Conditioned reflex (learned reflex action)

- Is acquired after birth by applying d/t stimuli (experience)
- It is not inborn
- It is dependent on past experience and training
- E.g; Ivan Pavlov's experiment

A. Before conditioning

- Food(unconditioned stimulus) ▸ RESPONE salivation (reflex action or unconditioned response)

- bell sound (neutral stimulus) $\xrightarrow{\text{RESPONSE}}$ no salivation (no response)

B. During conditioning

- Hand bell (CS) + food (UCS) $\xrightarrow{\text{RESPONSE}}$ salivation- unconditioned response

C. After conditioning

- Hand bell (conditioned stimulus) $\xrightarrow{\text{RESPONSE}}$ salivation (conditioned response)

The difference between reflex and voluntary action

Reflex action	Voluntary action
➢ Is an involuntary action in response to impulse imitated by stimulus	➢ Are responses to stimuli that are consciously controlled by the brain
➢ It is not under the control of the will	➢ It is under the control of the will
➢ E.g. blinking, salivation, coughing, peristalsis, secretion, heart beat	➢ E.g. Writing, Dancing, Eating, Driving, singing, Walking

Drug

- is any natural or artificially made chemical substances that alter the body.
- Some drugs are used to treat disease others affect the mind
- Used for medical or recreational purpose
- All medical drugs have label or instructions. E.g., precaution, warning

Based on their effects on the CNS drugs can be categorized as

A. Sedative/depressants:

- Reduces the rxn of CNS. E.g., tranquillizers and sleeping pills

B. Pain killer/analgesics:

- Suppress/relief from pain without curing the source of pain.
- Dull the senses by reducing the amount of neurotransmitters released at synapses

- E.g., Asprin, paracetemol, morphine and heroin

C. Stimulants:

- Increase the activity of the CNS
- Create a false feeling of confidence
- Make more alert to prevent sleep
- E.g., caffeine found in coffee, tea and cola drinks, chocolate and cocaine

D. Hallucinogens:

- Drugs that change once sensory perception by acting on the brain
- Cause people to see or hear things that do not exist. E.g., LSD & cannabis (hashish)

Drug abuse:

- Using drugs without medical advice
- Excessive and wrong use of drugs or drug dependence.
- **Drug dependence** is use a drug again and again and become addicted.
  - **Psychological dependence**: the need to keep using it becomes a craving or compulsion.
  - **Physical dependence**; where your body no longer works properly without added chemical extras.
- **Withdrawal symptoms**. an addict tries to stop using their drug
  - Feel very unwell,
  - Shaking, sweating, fever, headaches and pain
  - Cravings for the drug
- In Ethiopia caffeine, nicotine, tobacco, khat and alcohol are the legal recreational drugs but cannabis, LSD, cocaine and heroin are illegal drugs.

1. **Smoking cigarette**:

- Contain nicotine, tar and carbon monoxide
- The addictive drug in cigarette smoke is nicotine, physically addictive.
- Smoking increases your risk of the following diseases:

A. Coronary Heart Disease

- The chemicals in the tobacco smoke affect the walls of arteries.
- Reduces the blood supply to the heart and other areas of the body b/c the blood vessels supplying oxygen to the heart narrow. .
- Tend to damage the smooth lining of the arteries, **atherosclerosis** will occur.

B. Strokes

- Sudden illness due to the blood vessels taking blood to the brain damage or blocked
- lead to paralysis, memory loss and even death.

C. Lung Disease

- Tar & other chemicals in tobacco smoke damage the tissues of the lungs & lead to a greatly increased risk of developing chronic obstructive pulmonary disease & lung cancer.

D. Cancers (lip, mouth, throat, pancreas, bladder and kidney)

- many of the chemicals in cigarette smoke are carcinogenic (cancer causing)

2. **Alcohol**

- Contain ethanol
- addictive and poisonous.
- It dilates blood capillaries near the skin surface producing a feeling of warmth and well-being.
- It increases the heart rate as well as increases hunger
- Contributes to poor muscular coordination resulting in slurred speech and lack of balance
- Is a diuretic – increase urination
- Can cause headache due to dehydration and nausea (vomiting)
- Develop stomach ulcers and destroy brain cells and result in memory loss



- Alcoholics people who are addicted to alcohol may develop **cirrhosis of the liver** disease destroys your liver tissue. They can also get liver cancer
- Leads to accident (road, crime and unprotected sex)
- **Binge drinking** consuming excessive amounts of alcohol in a short period of time

3. Khat

- Khat leaves contain the drug **cathinone** w/c is absorbed into the bloodstream.
- Cause constipation, malnutrition and tooth decay
- Leads to accident (crime and unprotected sex)

4. Cannabis (marijuana)

- It is a dangerous hallucinogen drug that contain a chemical called cannabinoids,.
- **Delta-9 tetra hydro cannabinoid** (THC). THC is known to affect the brain cells responsible for memory, emotion and motivation.
- Hallucinogens are drugs that produce vivid waking dreams,

5. LSD (lysergic acid diethylamide)

- This is a very strong hallucinogenic drug made in the laboratory.

6. Cocaine

- It is a highly powerful stimulant drug that is finalized by depression.
- Users feel very alert and full of energy and it is prepared from coca plant.

7. Heroin (Opioids)

- Heroin is medically as very good painkillers and as recreational drugs,
- Increase the risk of liver diseases such as hepatitis, heart and brain damage.
- Heroin users don't feel hunger, pain or sexual feelings

Review questions

1) Which of these statements correctly explains the relationship between neurons and nerves?

A. A neuron is a bundle of nerves.
B. They are the same thing.
C. Neurons carry messages to the brain and nerves carry messages away from the brain.
D. A nerve is a bundle of neurons.

2) Which of the following is NOT part of a nerve cell?
A. cilia B. dendrites C. cell body D. axon

3) A nerve impulse crosses a synapse by means of:
A. electricity B. vibration C. chemical transmitters D. light rays

4) One of these actions is NOT a reflex. Which one?
A. blinking C. driving
B. moving your foot away when you tread on a pin D. a new-born baby gripping your finger

5) Which of the following drugs is not legal in Ethiopia?
A. nicotine B. alcohol C. khat D. cannabis

Work sheet

Choose the best answer (nerve system) part 3 10th

1. The nucleus of a cell is located in the
A. Axon C. Dendrites C. Cell body D. Synapse
2. Which of the following is not the part of central nerve system
A. Medulla B. Nerve C. cerebellum D. Spinal cord
3. The function of relay neuron is
A. Carrying nerve impulse from receptor to brain
B. Carrying nerve impulse from receptor to spinal cord
C. Carrying nerve impulse from brain to effectors
D. Linking sensory and motor neurons together
4. The gap across which an impulse passes from one neuron to another is an(a)
A. Axon C. Synapses C. Cell body D. Dendrites
5. Choose the correct statements
A. The structural unit of the nerve system is the neuron
B. Reflex arc is the functional unit of the nerve system

C. The structural unit of an organism is the cell
D. All of the above

6. Reflex response occurs more quickly than voluntary response because the nerve impulse in reflex action
   A. are activated without a stimulus
   B. are a serious of electrochemical waves transmitted from neuron to neuron
   C. travel a shorter distance than the impulse of voluntary response
   D. travel along the cranial nerve
7. A person under the inclosing influence of alcohol losses first his ability to think clearly , second his ability to walk straight, his ability to breath normally. Based on this evidence , which is the correct order in which alcohol affects the central nervous system.
   A. Cerebrum cerebellum medulla
   B. Medulla cerebellum cerebrum
   C. Cerebellum medulla cerebrum
   D. Cerebellum cerebrum medulla
8. Which of the following is called breathing center
   A. Cerebellum C. Medulla C. Hypothalamus D. puns
9. The dendrite of a neuron can carry an impulse only
   A. toward the brain C. away from the cell body
   B. toward the cell body D. away from the spinal cord
10. Speech and intelligence are associated with the
   A. Hypothalamus C. Medulla C. Cerebral hemisphere D. none
11. Which of the following system are responsible for the regulation and coordination of body activities?
   A. Nervous and muscular systems C. cranial nerve and spinal nerve
   B. Nervous and endocrine systems D. Brain and spinal cord
12. If you breathe deeply after running a kilometer distance, the part of the brain mostly activate is;
   A. pons C. spinal cord C. Medulla D. Thalamus
13. The human central nerve system consists of
   A. Cranial nerve and spinal cord C. Cranial nerve and spinal nerve
   B. Cranial nerve and brain D. brain and spinal cord
14. An example of a conditioned reflex
   A. Type writing C. knee jerk C. swallowing D. Sneezing
15. A drunken person may sway about because alcohol affects the normal function of the

A. Spinal cord B. Medulla C. cerebrum D. cerebellum

16. Which one of the following is not the part of peripheral nerve system?
    A. optic nerve C. Auditory nerve C. spinal cord D. spinal nerve
17. As you are working on this work sheet, now you think and try to memorize the answer to some questions. Which part of brain is helping you on this?
    A. Cerebrum B. pons C. cerebellum D. all
18. Which one is the functional unit of nerve system?
    A. Neuron C. Nerve fiber C. Reflex arc D. Nerve cell
19. What do we call a change of electric potential on the surface of neuron when it is stimulated?
    A. Resting potential C. neurotransmission
    B. Action potential D. polarization
20. Effector organ include
    A. Muscles and gland C. Sensory receptor and neuron
    B. Brain and Spinal cord D. efferent and afferent neuron
21. Which of the following is true about neurotransmitter? It is
    A. an electric events across the membrane of axon
    B. an electric potential on the surface of a cell
    C. a gap whenever one neuron ends and another begins
    D. a chemical released when a neuron reaches at a synapse
22. Which of the following statements describes the harmful effect of drugs? It
    A. Exposes the user to sexually transmitted disease
    B. Improve the living system the entire community
    C. Increase the concentration for proper management
    D. Help to make good decision throughout life
23. Which of the following action considered as reflex?
    A. Walking C. Drinking C. Breathing D. Sleeping
24. After information is processed in the central nerve system, instruction are sent to the body by specific neuron which are known as
    A. Afferent neuron C. efferent neuron C. effector neuron D. sensory neuron
25. Which one of the following statements is correct about reflex arc? It is
    A. flow of impulse from sensory neuron to the brain and spinal cord
    B. flow of impulse from the spinal cord to the brain and back to sense organ

C. flow of information from receptors to the spinal cord and to the effectors
D. unidirectional flow of information from receptors to spinal cord

Sense organs

- are organs that receive and transfer information about the body's senses to the brain.
- Are connected to the brain or spinal cord by nerve fibres
- Used to gain information about surrounding
- Sense organ contain sensory receptor that detect a particular stimulus,
- sensory organ is an organ that contains a large number of sensory receptor cells. E.g., eye
- Sensory receptors can change energy of the stimulus into electrical energy in nerve impulse

Receptor	Energy
Eye (retina, provides vision)	Light
Ear (cochlea, organ of hearing)	Sound
Ear (semi-circular canals, organ of balance)	Movement (kinetic)
Tongue (taste buds, enable us to taste)	Chemical
Nose (olfactory organ or organ of smell)	Chemical
Skin (touch, pressure and pain)	Movement (kinetic)
Skin (temperature receptors)	Heat
Muscles(stretch receptors)	Movement (kinetic)
Arteries & brain (chemo receptors responding to pH & CO_2)	Chemical

THE HUMAN EYE

- Used to respond to light or vision
- Stimulated by only light waves
- Is mechano receptors

Eye protection

- **Sockets** the cavity in the skull in which eye is situated.
- **Eyelid**s, **eye brow, eye lash** protect the eye from the entry of material like dust, sand
- The conjunctiva; transparent mucus membrane covering the front of eye ball
- Tear; a salty solution contain an enzyme called lysosome that kill some bacteria.
- Tear is secreted by tear gland or lachrymal gland.

Parts of the eye

A. Outer part: has 3 layer

1. The sclera:

- The tough, opaque external covering of the eye.
- Important to protect and maintain the shape of eye ball , white part of eye

2. Cornea:

- Transparent that allow light to enter, important to bend light ray toward retina

3. Aqueous humor:

- is a watery fluid that provides nutrients for cornea & lens, maintain the shape of eye ball

B. Middle part: Vascular

4. Choroid:

- Contain dark brown pigment scatter of light layers.
- Is rich in blood vessel that supply nutrient and oxygen to the cell of retina

5. Pupil: is a hole in the centre of the iris, through which light enter the eye

6. Iris:

- Contain two set of muscle called **circular** and radial colored part of the eye.

- Responsible for controlling the amount of light entering the eye through pupil.

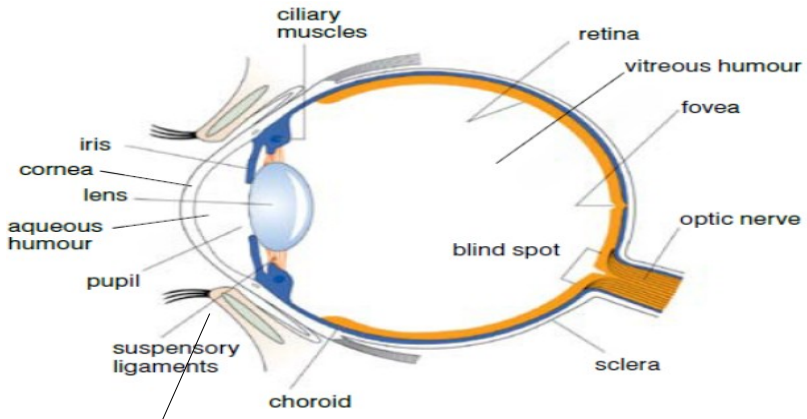


Fig: vertical section of human eye

Conjunctiva: transparent layer that protect cornea

In dim light

- the radial muscles contract
- the circular muscles relax
- The pupil is pulled open wide (it dilates).

In bright light,

- the circular muscles of the iris contract
- the radial muscles relax,
- Pupil very small (it constricts).

7. Lens: a flexible disc that helps focus light on the retina

- The lens is held in place by suspensory ligaments and the ciliary muscles.

8. Suspensory ligaments:

- elastic-like structures that suspend/hold the lens in place and pull lens into shape for focusing distant objects onto the retina

9. Ciliary muscles

- Adjust the lens shape to focus light on retina
- Eye muscles that automatically contract and change the shape of the lens by changing the tension of suspensory ligaments

C. Inner/sensory part

10. Retina:

- Is a light sensitive tissue lining the inner surface of the eye
- When an image is produced on the retina, light sensitive cells are stimulated.
- The light energy that falls on your retina is changed into electrical energy by the light-sensitive cells known as the **rods** and **cones** that make up your retina.
- Rods and cones contain chemicals that change when light falls on them.
- This change triggers an impulse in the affector neurons that make up the optic nerve.
- The impulses travel along the optic nerve to the visual areas of the brain.
- The rods and cones then use energy to restore the chemicals to their original form.
  - contains special light-sensitive cells (**photoreceptors)** called roads and cones

Rods

- respond to relatively low/dim light levels,
- do not give a very clear image
- They do not respond to different colors, everything looks black and grey
- Distributed evenly on retina except fovea
- Fewer in number on retina
- The pigment in the rods that responds to light is based on vitamin A. a lack of vitamin A in the diet causes **night blindness**.

Cones

- Responsible for bright and colored light
- They give a very clear, defined image
- Responsible for color vision
- More concentrated in and around fovea

- Occur greater on retina
- In human eye, there are $3.5x10^5$ cones and $6.5x10^7$ rods
- **Color blindness**:
  - Is unable to see all colors b/c they are missing one or more types of cones.
  - The genetic disorder inability to distinguish colors red, blue and green

11) Fovea (yellow spot)

- Is a small depression in the center of retina
- The most sensitive part of retina
- It contain cones, Most light ray are focused on it

12) **Blind spot**

- The point where light optic nerve leave the eye to form optic nerve
- There is no cones and rods on blind spot
- The light ray falls on blind pot do not form image

13. Vitreous humor:

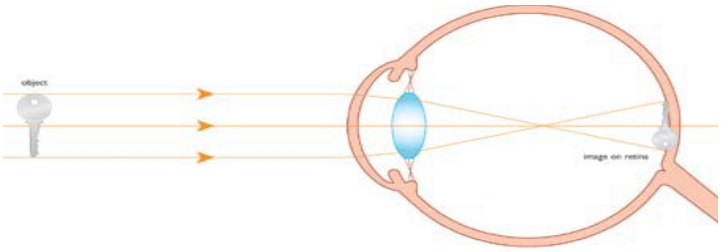
- Is jelly like (semi solid) substance that fill the eye ball behind retina.
- maintain the shape of eye ball

14. Optic nerve; the bindle of nerve fibers that transport nerve impulse from retina to brain

Focusing the light

- If you are going to see clearly, light from an object must be focused on your retina. For this to happen the light must be bent or refracted.
- Light rays are refracted when they pass from one medium to another – E.g; from air into water.
- In your eye, the light coming in is bent (refracted) twice – once as it passes from the air through the cornea and then again as it passes through the lens.

- As a result of this refraction the image is focused onto your retina – and it is also upside down. The optical areas of the brain interpret this inverted image so that you are aware of the world the right way up.
- In your eye, the light coming in is bent (refracted) twice – once as it passes from the air through the cornea and then again as it passes through the lens.
- As a result of this refraction the image is focused onto your retina & it is also upside down.



- The optical areas of the brain interpret this inverted image so that you are aware of the world the right way up.
- The light from a distant object reaching our eyes will be travelling in almost parallel rays, whilst the light from close objects will be spreading out or **diverging** very strongly.
- The cornea bends all of the light entering the eyes towards the retina, but it is the lens that makes sure that we can see both close and distant objects equally well. It does this by changing shape.
- Light from **distant** objects needs little further bending once it has passed through the cornea, so the lens is stretched long, thin and relatively flat and has little effect.
- However, light from close objects still needs some considerable bending to bring it into focus on the retina. The lens of the eye needs to be much thicker to focus light from near objects.
- It becomes shorter, fatter and much more convex (rounded) so that it bends the light much more. These changes in the shape of the lens are brought about by the contraction and relaxation of the ciliary muscles

that surround them, which in turn pull – or don't pull – on the suspensory ligaments that hold the lens in place.

Accommodation:

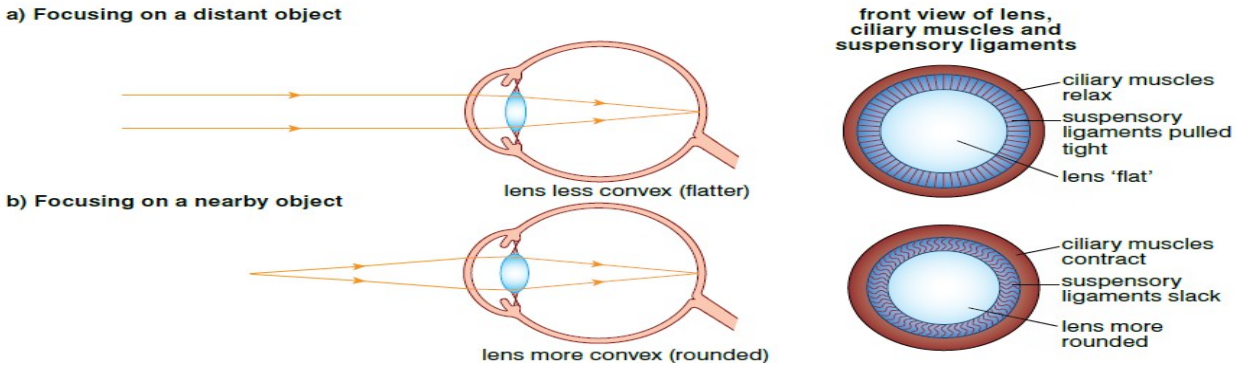
- Is the ability of the human eye to focus on objects at different distances (near and distance).
- Is made by action of suspensory ligaments and cilliary muscles and iris
- The relaxation and contraction of the cilliary muscles that change the shape of the lens and allow distant and close objects to be focused equally on retina

a) Focusing on a distant object

- Ciliary muscles relax
- Suspensory ligaments pulled tight
- lens 'flat' and less convex (lens flatter)

b) Focusing on a nearby object

- Ciliary muscles contract
- Suspensory ligaments slacks off
- Lens more rounded and more convex (lens to be thicker or rounded) so light bends more b/c it is more convex.



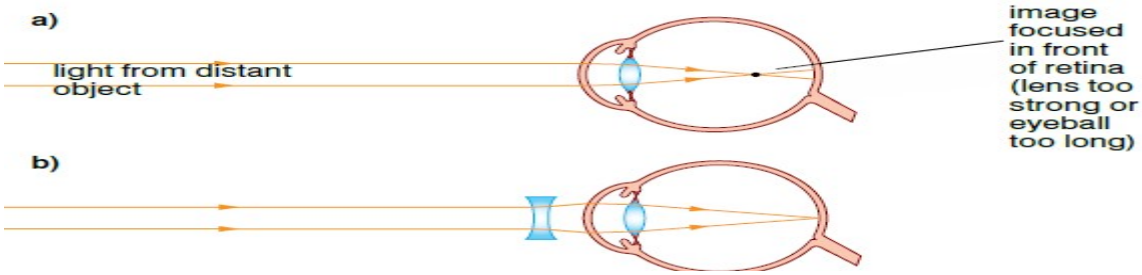
Common eye defects

1) Short sight (myopia)

- Ability to focus close objects

- A short-sighted person can focus clearly on things that are close to them but has much more difficulty with objects in the distance, which appear blurred.
- This may be as a result of a lens that is effectively 'too strong' – it is too curved even when the ciliary muscles are fully relaxed and so the light from distant objects is focused in front of the retina, making the image that actually lands on the retina spread out again and blurry.
- Another cause of short sightedness is when the lens is normal but the eyeball is particularlylong – and again this means light is focused in front of the retina.

- The condition where the eye can only sea near object
- Cannot sea objet from long distance
- Image of far objet formed in front of retina



Caused by

- Longer eye ball than normal
- Lens is 'too strong' and curved while cillary muscle relaxed

- **The problem is corrected by** wearing **diverging (concave)** lens that spread the light b/r it gets into the eye

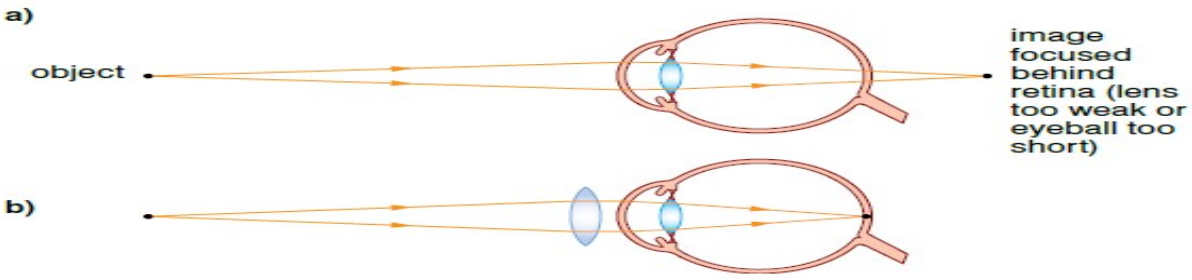
2) **Long sight (hypermetropia**)

- A long-sighted person can focus clearly on things that are at a distance but has much more difficulty with objects close to them, which appear blurred.
- This may be as a result of a lens that is effectively 'too weak' – it is too flat even when the ciliary muscles are fully contracted and so the light

from close objects is focused behind the retina, so the image that actually lands on the retina is spread out and blurred.

- Another cause of long sightedness is when the lens is normal but the eyeball is particularly short – and again this means light is focused behind the retina.
- This problem can be corrected using convex (converging) lenses that bring the light rays together more before they reach your eye.
- Now the thinner lens can bring the rays of light into perfect focus on the retina – or the short eyeball becomes the right length for the light rays to be focused on the correct point.

❖ A condition where the eye can only see far object
❖ Nearby object cannot see clearly/blurred
❖ Image of near object focused behind retina



Caused by

- Short eye ball then normal
- A lens is 'too weak' and flat while cillary muscle Contracted

Corrected by; wearing **diverging (convex)** lens

3) **Astigmatism**: is a type of refractive error in which the eye does not focus evenly on retina

❖ **Caused by;** The egg shaped eye instead of round
❖ The cornea is curved asymmetrically and this affects the way light is focused on retina.
❖ The shape of the eye is irregular – more egg-shaped than round – so the cornea is curved asymmetrically and this affects the way light is focused on your retina.



- ❖ In some people it is the lens rather than the eyeball itself that is an unusual

Corrected by: wearing eye glass with irregular lens, cylindrical and equally curved lenses

3-D vision

- gives us enough information to build up a 3-D picture of the world around us.
- Used to give us the judgement of distances and depth depend on using both eyes that we need to do so many things, from threading a needle to driving a car.
- This amazing spatial awareness comes from the overlapping of visual field from our two eyes.
- If you look at the world through one eye it appears flat.
- Hold out both hands, with one finger pointing on each. Bring your fingers together with the tips meeting in one smooth movement. Now close one eye and repeat the manoeuvre – it isn't so easy!
- Seeing in depth depends on you using both eyes.
- Each eye sees a slightly different view of the same object.
- Your brain combines the two images and uses all the information to give you a 3-D view of the object.

THE EAR

- The human ear is responsible for Hearing, Balance and position of the body
- Respond to sound (chochlea) and movement (semicircular canal)
- Stimulated by only sound waves
- Are mechanoreceptors and respond to mechanical stimuli
- Are sensitive to gravity, movement and sound
- Sound is produced by vibration of particles with a medium
- Human ear is sensitive to wave length 40-20,000 Hz (cycles per second)
- The audible range of dog reaches 40,000 Hz

- The audible range of bat reaches 100,000 Hz
- Human speech 500-3000 Hz

The ear divided into three regions

A. Outer (external ear)

1) **Pinna:** direct sound wave into ear canal
   - Helps to know the direction of sound
   - A funnel shape extension of skin and cartilage

2) Ear canal (auditory)

   - Used to direct sound wave to eardrum

   At the entrance of the ear canal ate a number of small hairs

   - Have gland to produce wax inside ear canal
   - Wax use;
     - ✓ Trap dust and germs
     - ✓ Lubricate the ear drum

3) Ear drum (tympanum)

- A tiny and delicate membrane

B. The middle ear (air filled cavity)

- It contain three tiny bones (**ossicles**) w/c are the smallest bones in the body
  - ✓ **Hummer /malleus/**attach to ear drum
  - ✓ **Anvil /incus/**
  - ✓ **Stirrup /Stapes/** attach to oval window and it is the smallest of the 3 tiny bones

Eustachian tube: is a narrow tube that connects the middle ear to the back of nose and throats

- helps to equalize air pressure between outer and middle ear

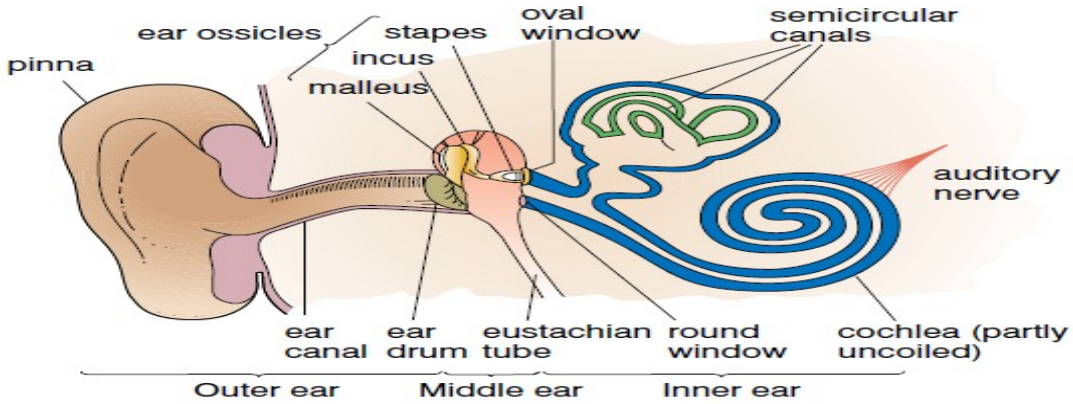
C. The inner ear/internal: fluid filled cavity, consists;

- **Cochlea** a coiled tube
  - ✓ Involves with hearing
  - ✓ Contain nerve ending of auditory nerve
  - ✓ It is sensitive to sound vibration

- **Semi circular canal;** consists of cell that are sensitive to the motion of body
- **Utricullus and sacculus; are** concerned with the balance and posture

❖ **Auditory nerve:** is a nerve fibre that joins the affecter neurons to the brain.

- Carries an impulse from middle ear to the brain



The path way of vibration in the ear

Pinna → ear canal → eardrum → Hummer /malleus Anvil /incus/ Stirrup → oval window → cochlea → auditory nerve → brain sense of hearing

Common disorder of the ear

❖ Partial hearing loss is called **hearing impairment**

❖ The total loss of hearing is called **deafness**

❖ Some of the common hearing impairment and deafness are; obstruction of auditory passage, inflammation, damage of ear drum, ossicles & auditory nerves (cannot be restored), loud noise and infection

TASTE AND SMELL

A. Tongue: Have sensory receptors sensitive to dissolved substance

❖ Respond by chemical stimuli

- The sensory receptors of taste are located on the upper surface of the tongue known as **taste bud**.
- The five different types of taste buds spread evenly across the tongue
- There are five basic taste sensations are **sweet, sour, bitter and salt** recently discovered a fifth taste called **umami** .
- **Umami** is a very savory flavor found in foods such as meat, cheese, broth and mushroom.

B. The nose: Smell is caused by chemical stimuli

- Smell receptor are called olfactory cells which are located in the roof of nasal cavity
- The receptors for smell are located in the upper parts of the nasal passages.
- The specialized cell of smell are similar to taste however, nose detects dissolved chemical at distance
- Smell receptors are much more sensitive than taste receptors.
- The reason why you cannot taste foods well when suffering from a cold is that with your nasal passages inflamed and coated with mucus, your smell receptors can not work.

THE SKIN AS A SENSE ORGAN

C. Human skin are sensitive to five type of stimuli touch, temperature, pain and pressure. Due to the following receptors

a) **Meissners corpuscles;** Touch
b) **Pacinin corpuscles;** pressure
c) **Thermo receptors;** Temperature
d) **Nocireceptors;** pain

D. Importance of the skin

- It contains sense organ (sense of touch, temperature, pressure and pain)
- Respond to movement and heat
- It forms a waterproof layer around body tissues,
- It protects from the entry of bacteria and other pathogens.

- ❖ It protects from damage by UV light from the sun.
- ❖ It is an excretory organ (nitrogenous wastes are lost in your sweat).
- ❖ It is vital in controlling body temperature.

Skin has three main layers.

a) Hypodermis; the lower fatty layer of skin

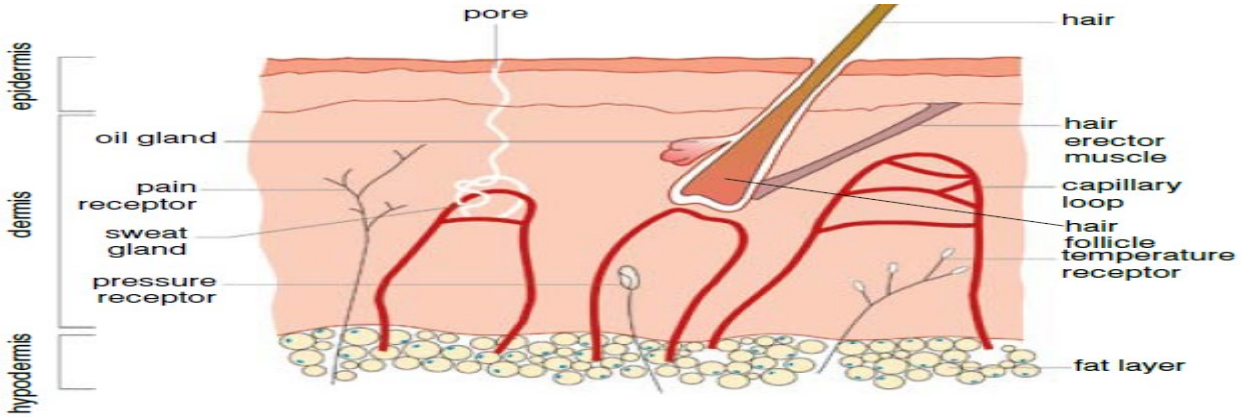
- ➢ Contains fatty tissue which helps to insulate the body against heat loss.

b) Dermis; the middle layer

- ➢ Contains the blood vessels, lymph vessels, sweat glands, sensory receptors and the hair follicles.
- ➢ Closely involved in temperature control in homeostasis and in sense of touch.

c) Epidermis; the upper/outer most layer of skin comprising dead cells.

- ➢ prevent water loss and against the entry of pathogens.
- ➢ particularly involved in the homeostatic mechanisms of the skin



Review questions

1) Which of the following is not part of the eye?

A. lens B. retina C. pinna D. eyelid

2) Imagine you have been out on beach looking at some friends in the sea. You walk into the shade of a palm tree & begin to read a book. What changes would take place in your eyes?

A. Your pupils would constrict and your lens would become flatter and less convex.

B. Your pupils would constrict and your lens would become rounder and more convex.

C. Your pupils would dilate and your lens would become flatter and less convex.

D. Your pupils would dilate and your lens would become rounder and more convex.

3) Which is the correct order of the bones in the middle ear, from the eardrum inwards?

A. hammer, anvil, stirrup C. stirrup, anvil, hammer

B. anvil, hammer, stirrup D. none of these

4) Which is the most recently discovered sense of taste?

A. sweet B. bitter C. sour D. umami

Work sheet

Choose the best answer (sense organ)10 th

1) Which of the following stimuli respond by tongue?
   A. sound C. movement C. light D. chemical
2) How is the pressure in the middle ear equalizing to that in the throat when you are flying in an aero plane?
   A. By shacking your head continuously
   B. By pinna the Eustachian tube
   C. By closing the pinna over the ear canal
   D. By plugging Cotton into your ear canal
3) Which of the following bones of the middle ear fits between the other two bones?
   A. Stapes C. Malleus C. Stirrup D. incus
4) Which one of the following eye defects is correctly matched with its corrective measure?
   A. Long sight- diverging lens
   B. long sight-convex lens
   C. Short sight –irregular lens
   D. Astigmatism –any eye glass
5) What is accommodation? it is the ability of the eye
   A. Change the shape of lens to focus object

B. Change the shape of retina to focus object
C. Focus far object then close object
D. Focus object during the night time

6) Astigmatism is one of the common eye defects which is caused by
A. Regular shape of the eye which become more round
B. Lens that is too strong and curved while ciliary muscle is relaxed
C. Lens is two weak and flat while ciliary muscles contracted
D. The egg shape of eye instead round

7) How image is formed in human eye? When light from an object is focused on
A. Retina B. Iris C. cornea D. Lens

8) Which of the following structure of human ear collects sound waves?
A. Eustachian tube C. ear canal C. Pinna D. Cochlea

9) The flexible disk that help to focus light on retina of the eye is
A. Choroid C. Iris C. pupil D. lens

10) Older people have accomidation problems and they cannot focus easily on close objects? What is the cause of this problem
A. Hardening of the lens
B. Roughness of the eye ball
C. Weakening of the lens
D. Smoothness of the eye ball

11) Which of the following structure is different from others?
A. Malleus C. Incus
B. Stapes D. Sclera

12) Which of the following part of the eye is responsible for controlling the amount of light reaching the retina?
A. Cornea C. Pupil
B. Iris D. Choroid

13) Which of the following ear bones directly transmits sound to the cochlea?
A. Stapes C. Malleus
B. Incus D. Ampulae

14) When Melat look at near object forms blurred image. As the object far and far to him, the image become clear. Melat's eye defects is called
A. long sight C. short sight
B. Astigmatism D. Color blindness

15) Eye color such as black or blue eye, actually refer the color of?
A. Pupil C. Iris C. Sclera D. Retina

Choose the best answer (sense organ and nervous system) 10th

1. Receptor that detect body passion are found in
   A. nose C. skin C. ear D. eye
2. The cell responsible for color vision in vertebrates are called
   A. Rod cell C. cone cell C. bipolar cell D. scapula cell
3. The fluids that fill the chamber of the eye in front of the lens is known as:
   A. Tear C. salty water
   B. aqueous hummer D, vitreous hummer
4. The iris is the continuation of the;
   A. Cornea C. choroid C. Sclera D. retina
5. Which of the following abnormality of the eye cannot be corrected by wearing of leans?
   A. Astigmatism C. night blindness C. Short sightedness D. long sightedness
6. Which structure of human eye does not refract light?
   A. Cornea C. lens C. pupil D. vitreous hummer
7. Which of the following eye problems is caused by poor diet;
   A. Trachoma C. astigmatism C. night blindness D. short sightedness
8. Suppose you were sitting in your class room and studding your notes. Suddenly you heard a sound outside in the field and glanced through the window. What happens the lens of your eye?
   A. It became rigid C, it become thicker
   B. it became thinner D. no change at all
9. Which ear ossicle vibrates last d transmits sound and wave to the inner ear?
   A. Anvil C. Hammer C. stirrup D. malleus
10. Nerve impulse are carried from the eye to the brain by:
   A. Optic nerve C. Auditory nerve C. Olfactory nerve D. Spinal nerve
11. What do we call the regions of the retina where light sensitive cell are not found?
   A. Yellow spot C. Optic lobe C. conjunctiva D. blind spot
12. As one get older he / she become long sighted. What kind of eye glasses would you advise him/ her to were, eye glass with
   A. Concave lens C. convex lens.
   B. combination of the two D. diverging lens
13. The sense of receptor in the skin that enable as to distinguish between rough and smooth surface is known as;
   A. meissines's corpuscles B. pacinian corpuscles C. thermo receptors D. Nocicreptorse
14. which of the following structure is found in the fluid filled portion of the ear ;
   A. ossicles C. Semicircular canal C. eardrum D. pinna

15. When Eshetu looks at a distance object forms a blurred image. As object gets closer and closer to him, the image becomes clear.
    A. Long sight C. short sight C. night blindness D. Astigmatism
16. The incoming sound wave pass from middle ear to inner ear :
    A. Eardrum C. Oval window C. Eustachian tube D. Ossicles
17. Eye color, such as brown, blue and black eye refers to the;
    A. Pupil B. Conjunctive C .Iris D. cornea
18. Which of the following sense are detected the same sense organ?
    A. Sight and smell C. smell and taste
    B. Hearing and balance D. Hearing and sight
19. Older people have accommodation problems and they cannot focus easily on close objects? What is the cause of this problem?
    A. hardening of the lens C. roughness of the lens
    B. Weakening of the lens D. smoothness of the lens

✓ **Choose the best answer (sense organ and nervous system) PART2 10th**

1) Which of the following is not the cause of short sight?
   A. Long eye ball C. short eye ball C. Weak cilary muscle D. rigid lens
2) In the eye of long sighted person image of near object formed;
   A. in front of the retina C. behind the retina
   B. On the retina D. No image is formed
3) Which structure of the brain is situated in the posterior region?
   A. Cerebrum C. thalamus C. medulla oblongata D. Hypothalamus
4) When you learn biology in your class room, which portion of your brain helps you to remember the concept?
   A. Hypothalamus C. Medulla oblongata C. Cerebrum D. Cerebellum
5) The axon of motor neuron is connected in;
   A. Relay neuron C. Motor neuron C. muscle fiber D. dorsal root
6) Which of the following is true of a resting neuron?
   A. it is polarized C. it is depolarized
   B. it has an action potential D. out sides member become negative
7) The peripheral nervous system is composed of;
   A. Cranial & spinal nerve C. motor nerve only
   B. spinal nerve only D. sensory nerve only
8) Neuron in spinal reflex make synapse in the;
   A. White mater C. grey mater C. Dorsal root D. ventral root
9) A long cytoplasmic fiber that send message to the surrounding neuron is known as;

A. Axon C. nucleus C. cell body D. auricles

10) Which of the following is situations is the most likely to produce a reflex action?
A. Seeing a meal C. reading text book C. Climbing tree D. receiving a present

11) Suppose a person holds a very hot object and does not feel a burning pain in his hand. Which of the following neuron is probably damage in his hand?
A. Sensory C. motor C. relay D. effectors

12) The nerve impulse that carry impulse to muscle and glands are called?
A. Relay neuron C. motor neuron C. sensory neuron D. afferent neuron

13) The most anterior part of your brain is called;
A. Cerebrum C. cerebellum C. spinal cord D. medulla

14) In the reflex action, to which of the following does impulse reach last? To;
A. Effectors C. efferent neuron C. receptor D. coordinated

15) Which of the following is a condition reflex?
A. Blinking of eyes C. sneezing due to dust
B. salivating on seeing food D. swallowing food

16) Which of the following part of the eye responsible for controlling the amount of light entering the eye?
A. Cornea C. pupil C. Iris D. choroid

17) Which of the following ear bones directly transmit sound waves to cochlea?
A. Stapes C. Malleus C. Incus D. Ampulae

18) How image is formed on human eye? when light forms an object is focused on
A. Retina B. Iris C. Cornea D. lens

19) Which of the following human ear collects sound waves?
A, ear canal B. Pinna C. Eustachian tube D. Cochlea

20) Which of the following bones of the middle ear fits between the other two
A. Stapes C. Malleus C. Stirrup D. Incus

THE ENDOCRINE GLAND

- Glands are structures that produce hormone and other useful substance.
- There are two types of glands

1) EXOCRINE GLAND

- Release its secretion through its ducts (tube)

exocrine gland	Secretion	Function
Sweat gland	Sweat	Remove heat and regulate temperature
Salivary gland	Salivary with enzyme	Digestion, lubrication, moisten food
Mammary gland	Milk	Feeding of young
Pancreatic gland	Pancreatic juice	Digestion of food
Digestive gland		

2) **Endocrine gland (ductless gland**)

- Gland without duct
- Transport their secretion to the site of action through **blood vessels**
- Produce a chemical called **hormones**
- **Hormones** area chemical messenger which carries information from one part of the body to other.
- Hormone exert their influence on certain body called **target organs**
- Hormone have a long term effect on the body such as growth, development, metabolism, reproduction
- Some examples of endocrine gland;

1. Pituitary gland

- **Found in the brain**
- is called **master gland** or an **endocrine orchestra b/c** its hormone regulates growth, reproduction and Control the activity of other endocrine glands to secrete their hormone.
- Pituitary gland secret the following hormone

A. Growth hormone regulate the development of bone and muscle

- Low secretion **dwarfism(very short)**
- High secretion **gigantism (Very tall)**

B. Thyroid stimulating hormone (TSH) stimulate thyroid gland to produce thyroxin hormone

C. Gonadotrophic hormone(GTH)

- **Follicular stimulating hormone(FSH**)stimulate the development of egg in ovary
- **Luteinizing hormone(LH)** stimulate the production of progesterone in female and testosterone in male

D. Antidiuretic hormone stimulate reabsorption of water by kidney tubules

E. Oxytocin hormone initiate uterus contraction to cause birth

2. Thyroid gland

- Is the largest gland in the body
- located in the neck region around trachea and larynx (in front of wide pipe)
- Secret thyroxin hormone w/c made up of iodine and amino acid.
- thyroxin involve in regulation of
  - rate of metabolism
  - stimulate the conception of oxygen by most cell
  - development of brain in children

Hyperthyroidism: over production of thyroxin

- Metabolic rate will rise
- Heartbeat, blood pressure rises
- People with this condition may have
  - Loss of weight(Thin body)
  - Irritable or restlessness
  - Heavy sweat

Hypothyroidism: Low level of thyroxin

- Caused by lack of iodine in the diet w/c involve in thyroxin production.
- Metabolic rate decrease
- People with low thyroxin;
  - People feel tired and lack of energy
  - Weight gain
  - Miscarriage in pregnant women

- Reduce mental and physical development in children known as **cretinism**

- **The** deficiency of thyroxin in adult human results thyroid gland enlarges called **goiter**
- Goiter prevented by including more iodine in our diet.
- Source of iodine: iodized salt, sea food and onion
- Reduced metabolic rate is associated with decreased oxygen consumption, heart beat and body temperature
- Goiter: is a deficiency disease w/c is marked enlargement of the thyroid gland as a result of mainly lack of iodine b/c without iodine, the thyroid gland works very hard to try and make enough thyroxin but it cannot do it.
- Women and children tend to be more affected than men. This may be because women have big demands on their bodies with pregnancy and breastfeeding, while children are growing.
- The problem is worse in rural areas, particularly in the mountainous regions where any iodine tends to be washed away out of the soil.

3. parathyroid gland

- Found embedded in the thyroid gland
- Four tiny structure found at the back of thyroid gland
- Produce a hormone called **parathyroid hormone (Parathormon)**
- parathyroid hormone control the amount of calcium ion and phosphate in the blood
- Calcium ion necessary for bone formation.
- parathyroid hormone promotes the release of calcium ion from;
  - Bone
  - absorption from calcium ion from food in small intestine
  - re-absorption of calcium ion from kidney tubules

4. PANCREAS: islets of Langerhans'

- Pancreas and gonads are both endocrine and exocrine glands
- Contain endocrine gland called **'islets of Langerhans'**

- Is a gland that produce digestive enzymes and Secretes two hormone known as **insulin** and **glucagon**
- Control blood glucose level in the body
- Insulin & glucagon are **antagonistic hormones** b/c they have opposite effect on glucose level.

INSULINE

- Secretes when blood glucose level higher than normal
- Reduce the glucose level in the blood and increase glycogen
- **Decrease blood glucose level by;**
  - Glucose is removed by cellular respiration
  - Increase the take up of glucose by cells
  - glucose is converted into glycogen in liver and muscle cell **glucose → glycogen**

GLUCAGON

- Secretes when blood glucose level higher than normal
- Is released in response to decrease in blood glucose below the normal
- Increase glucose level in the blood
- Glucose (in blood) ← insulin → glycogen (stored in liver and muscle cell)

  ← Glucagon
- **Increase blood glucose level by;**
  - Stimulate the conversion of glycogen into glucose **glycogen → glucose**
  - Stimulate the formation of glucose from amino acid and fat
- The deficiency of insulin and glucagon cause the disease called **diabetes**
- Deficiency of insulin followed by breakdown of muscle tissue, loss of weight and tiredness while excess insulin results in hunger and sweating.

- Insulin from pancreas stimulates the liver to convert glucose into glycogen whereas the glucagon stimulates the liver to convert glycogen to glucose.
- **Type 1 diabetes :** appeared in children, It is inherited ,cannot be avoid it
- **Type 2 diabetes:** appeared in person life, can be linked , being obese or under weight

5. ADRENAL GLAND

- Found on the top of kidney
- Produce adrenaline hormone w/c prepare the body for stressful situation either fight or flight.
- Adrenal gland have two separate and independent parts
  - Adrenal cortex (outer layer)
  - Adrenal medulla (Inner layer)

a) Adrenal medulla (fight and flight hormone)

- Produce a hormone called **adrenalin**
- Secret under stress, emergency, excited, freighted situation
- Important for preparing the body for action
- The main change produce by adrenalin
  - Increase heart rate
  - Increase breathing rate
  - Pupil dilates
  - Body hair stand

b) Adrenal cortex

- Secret complex steroid hormone called **corticoids**
- Control certain phase carbohydrate, fat and protein metabolism
- Another hormone release by adrenal cortex is **aldosterone**
- This hormone promotes the re-absorption of sodium and chloride ion in the kidney tubules, Therefore affect water and salt balance in the blood

6. GONADS: testes and ovary (sex gland)

- Produce sex hormones
- Become active at the time of puberty

A. Testes

- Puberty in boys begins b/n 9 and 15 years old
- **P**roduce male sex hormone **testosterone**
- Control male secondary sexual characteristics such as:
  - The whole body growth spurt
  - Tests began to produce sperm
  - Pubic hair (hair around sex organ) , body and facial hair began
  - Larynx enlarges so voice deepens
  - Penis enlarges and the skin of penis and scrotum may darken
  - Body become ,more muscular
  - Brain changes, adolescents become more independent, more questioning and start to look beyond their families
  - Primary sexual characteristics: present at birth
  - secondary sexual characteristics: develop during puberty

Parts of male reproductive system

1) Scrotum: a sack where testes are situated.

2) **Vas deferens:** a tube w/c carries sperm to urethra

3) Urethra: a tube w/c carries urine from bladder as well as from vas deferens through penis

4) **Penis:** contain erectile tissue.

- When the male sexually excited this tissue fills with blood that causing the penis to become erect.
- During sexual intercourse the erected penis is inserted into vagina b/r ejaculation of the semen (sperm + seminal fluid=semen).
- Ejaculation occurs during climax copulation (sexual intercourse).
- Most sperm takes about 4-8 hours to reach oviducts.
- Sperm can survive in female for 1-3 days but are only highly fertile for 12-24 hours.

5) **Epididymis:** coiled tube that used to pass sperm and sperm are concentrated here

6) Prostate gland: secrete mucus and alkaline fluid w/c is released during ejaculation and help to neutralize the acidity of vagina and decrease the normal acidity of the vagina to pH 6 up to 6.5 during copulation.

7) **Cowper gland:** secrete mucus and alkaline fluid into urethra

8) Seminal vesicles: secrete mucus and watery alkaline fluid

B. Ovaries

- Puberty in girls starts b/n ages of 8-14.
- At the age of puberty, Produce female sex hormone called **progesterone** and **estrogen**

a. Estrogen

- Just as in boys, puberty is controlled by hormones from the pituitary gland in the brain and from the gonads themselves – in this case the ovaries.
- FSH from the brain stimulates the ovaries to become active and start producing the female sex hormone oestrogen.
- As the levels of oestrogen rise and the body responds, all kinds of changes are triggered and the female secondary sexual characteristics develop.
- Cause the development of female secondary sexual characteristics such as;
  - The whole body under goes growth spurt
  - Mammary glands (Breast develop)
  - External genital enlarges
  - Widening of hip
  - Ovaries began to produce egg
  - Menstruation begins
  - Pubic hair grows
  - Voice become thinner

b. **Progesterone**

- ❖ Preparing uterine lining for pregnancy
- ❖ Stops the development of additional while the women is pregnant
- ❖ Prevent menstruation during pregnancy

Parts of female reproductive system

a) **Fallopian tube (oviduct):** tubes that carry eggs from ovaries to uterus.

b) Uterus (womb): if fertilization takes place, the embryo implants in the wall of the uterus and growth there until birth. The uterus growth much larger **during pregnancy.**

c) Cervix (neck of womb): is narrow entrance to the uterus from vagina. It is normally blocked by a plug of mucus and a ring of muscle can close it.

d) **Vagina:** a muscular tube about 8-10 cm long whose walls contain elastic tissue.

- ▸ The lining is folded. It stretches during child birth to allow passage of baby and during sexual intercourse when the penis is placed in it.

e) **Clitoris:** small structure w/c is equivalent to the male penis and like penis can erect.

- ▸ Sexual excitement causes the clitoris of the female to become erect as penis & reaches about 3-5 cm.

Menstrual cycle

Menstruation; monthly discharge of blood and cell shed from endometrium

- ❖ Hormones control the whole process of menstruation and pregnancy.
- ❖ The menstrual cycle is a sequence of events which takes place approximately every four weeks throughout the fertile life of a woman, from puberty to 50 years of age.
- ❖ After puberty FSH starts ova developing from immature ova
- ❖ FSH stimulate to secret oestrogen



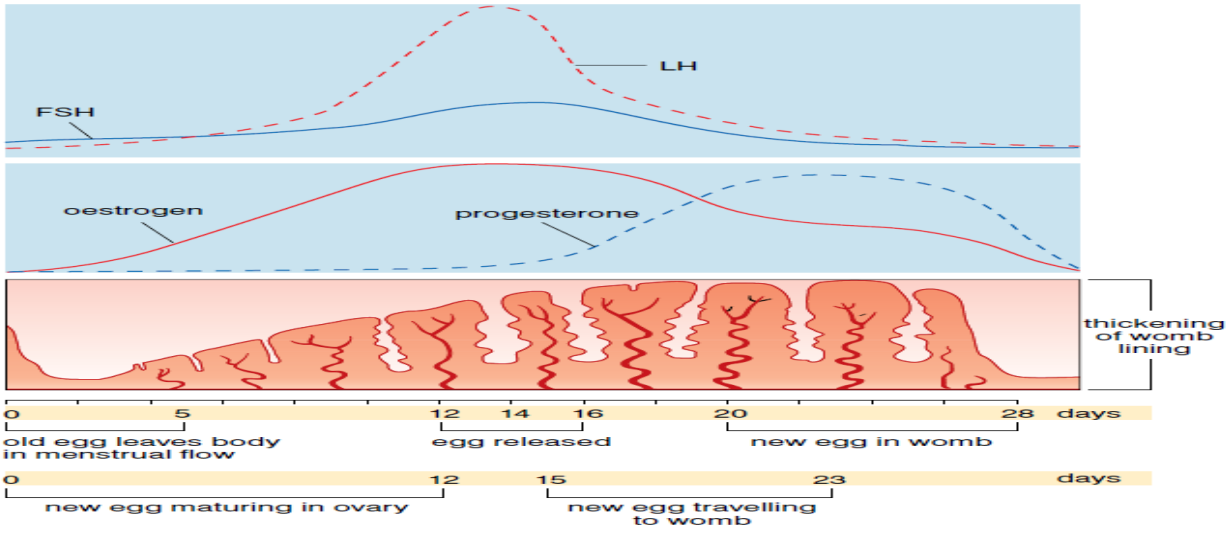
- A baby girl has ovaries full of immature ova, but they do nothing until after puberty. Then, once a month, a surge of the hormone FSH from the pituitary gland in the brain starts a few of the ova developing.
- FSH also affects the ovary itself which starts making the female hormone oestrogen. This in turn stimulates the uterus to build up a thick, spongy lining with lots of blood vessels ready to support a pregnancy.
- About 14 days after the ova start ripening, one of them bursts out of its follicle. This is called ovulation and when it happens the hormone levels from the pituitary begin to drop dramatically.
- After ovulation the remains of the follicle forms the **corpus luteum** (which means yellow body because it is filled with a yellowish fat) & this secretes **progesterone**.
- Progesterone makes sure that for some days the uterus lining stays thick and spongy and stimulates the growth of more blood vessels, ready to receive a fertilised ovum.
- If a pregnancy occurs the embryo will immediately get a rich supply of food and oxygen. But most months the ovum is not fertilised and the woman does not become pregnant.
- About ten days after ovulation (when no pregnancy has occurred) the ovary reduces the levels of both oestrogen and progesterone.
- As the chemical messages change again the blood vessels which are supplying the thick spongy lining of the uterus close down.
- The lining detaches from the wall of the uterus and is lost through the vagina as the monthly period or bleeding.
- However, if the ovum has been fertilised it will reach the uterus and sink into the thick, spongy lining, attach itself (**implant**) and start to develop.
- Menstrual cycle occur between two coordinated events

Ovary:

- Graffian follicle ripens and burst releasing the mature egg into the fallopian tube. This condition is called **ovulation**

Uterus:

- Prepare uterine wall to receive zygote (fertilized egg)
- After ovulation the follicle undergoes change become **corpus luteum**
- the corpus luteum produce a hormone called progesterone
- **If the egg is fertilized** progesterone stimulate:
  - The wall of uterus thicken
  - The uterus develop new blood vessels
  - Stop further ovulation
- The egg moves down the oviduct by muscular contraction of the oviduct wall
- **If the egg is not fertilize**, the ovum dies and the wall of uterus breakdown and menstruation occur



Symptoms of menstrual cycle

- Nausea, headache, etc.
- Reduce the symptoms by using hot and other liquid drinks, exercise and have a sex.

Hormones involve in menstrual cycle

A. Produce by pituitary gland

1) Follicular stimulating hormone FSH)

- Stimulate the development of egg in ovary
- Stimulate the ovary to produce estrogen

- stimulates the development of a follicle in the ovary, and within the follicle the egg matures and ripens.
- FSH also stimulates the ovaries to produce hormones, particularly oestrogen.

2) Latinizing hormone (LH)

- Stimulate the release of egg from ovary
- Stimulate the ovary to produce progesterone
- stimulates the release of the egg from the ovary in the middle of the menstrual cycle
- affects the ovary to produces progesterone and to keep the uterus lining in place.

B. Produce by ovary

3) Oestrogen

- Responsible for the development of feminine traits
- stimulates the lining of the uterus to build up in preparation for pregnancy. It also affects the pituitary gland.
- As the oestrogen levels rise, the production of FSH by the pituitary gradually falls – which in turn means the oestrogen levels fall.
- The rise in oestrogen levels has the opposite effect on the levels of the other pituitary hormone, LH.
- As oestrogen rises, the production of LH goes up. When LH reaches its peak in the middle of the menstrual cycle it stimulates the release of a ripe egg from the ovary.

4) **Progesterone**

- Prepare the uterus for implantation of fertilized egg
- maintains the thickened lining of the uterus and stimulates the growth of blood vessels in the lining to prepare for a pregnancy – and if a fertilised ovum arrives in the uterus, progesterone helps to maintain the pregnancy.
- By the end of the cycle, when the menstrual bleeding is about to start, all of the hormones are at a low ebb.



- Because the ovaries only contain a limited number of ova, women do not have periods throughout their lives.
- Eventually the ova in the ovaries run out. The hormone levels drop, the ovaries and uterus shrink and the woman stops having periods.
- She is no longer fertile. This change, which takes place around the age of fifty, is known as the menopause.
- Menopause: is the cession of monthly period and marks the end of a woman's fertility (age of b/n 48-50) b/c ovaries contain only a limited number of ova.
- Symptom of Menopause: night sweat, depression, irritability, fatigue and softening of bones due to loss of calcium.

Nervous and hormonal systems in co-ordination

- So as you have seen, some hormones do bring about rapid responses – adrenaline, insulin and glucagon are examples of these.
- But many others such as thyroxine, growth hormone and the sex hormones have a much longer, slower impact on the body – but they are no less important for co-ordination and control.
- Both the nervous system and the hormone system are important for co-ordination and control.
- They both have features in common, but in many ways they are very different.

Nervous system:

- Electrical messages travel along neurons.
- Chemical messages travel across synapses.
- Messages travel fast.
- Messages usually have rapid effect.
- Usually a short-lived response.
- Nerve impulse affects individual cells, e.g. muscle cells, so have a very localised effect.

Hormonal control:

- Messages transported slightly more slowly in the blood – minutes rather than milliseconds.
- Only chemical messages involved.
- Often take longer to have an effect.
- Effect often widespread in the body – affect any organ or tissue with the correct receptors.
- Effects often long lasting.

The combination of nervous and hormonal control enables your body to work as a co-ordinated whole – and plays a vital role in the homeostasis.

Gland	Hormone	Functions of the hormones
Pituitary	Growth hormone	Controls the growth rate of children
	Thyroid stimulating hormone (TSH)	Stimulates the thyroid gland to secrete thyroxine
	Anti-diuretic hormone (ADH)	Controls the water content of the blood by its effect on kidneys (see homeostasis)
	Follicle stimulating hormone (FSH)	Stimulates egg development and oestrogen production in women and sperm production in men
	Luteinising hormone (LH)	Stimulates egg release in women and testosterone production in men
Thyroid	Thyroxine	Controls the metabolic rate of the body
Pancreas	Insulin	Lowers blood sugar levels
	Glucagon	Raises blood sugar levels
Adrenal glands	Adrenaline	Prepares the body for stressful situations – 'fight or flight'
Ovaries	Oestrogen	Controls development of female secondary sexual characteristics Involved in menstrual cycle
	Progesterone	Involved in menstrual cycle
Testes	Testosterone	Controls development of male secondary sexual characteristics Involved in sperm production

Review questions

1) Which of the following endocrine glands secretes a hormone that directly affects the metabolic rate of the body?

   A. pituitary gland B. ovary C. thyroid D. pancreas

2) Which of the following reproductive hormones is produced by the pituitary gland?

   A. oestrogen B. testosterone C. follicle stimulating hormone D. progesterone

3) Which of the following changes takes place at puberty ONLY in boys?

A. growth spurt
C. body shape changes
B. larynx enlarging and voice deepening produced
D. mature gametes

REPRODUCTIVE HEALTH

- **Sexual intercourse** the erect penis of male entering the vagina of the female
- **Ejaculation** the release of semen from the penis
- **Fertilization** a single sperm combine with ovum
- **Zygote** a fertilized ovum
- The path of sperm in male reproductive structure describe as

  Testis → epididymis → vas deference → urethra
- The pathway of sperm in female reproductive organ

  Vagina → cervix → uterus → oviduct/ Fallopian tubes
- The process of releasing egg from ovary to fallopian tube is called **ovulation**
- Fertilization takes place in the oviduct (fallopian tube)
- Fertilized egg (ovum) is called **zygote**
- The sperm gets inside the body of the woman during **sexual intercourse**.
- The erectile tissue in the penis fills with blood so that it becomes erect and can be placed inside the vagina.
- The sperm move from the testes through the urethra, and semen containing millions of sperm is released inside the vagina in a process known as **ejaculation**.
- When a single sperm joins with the ovum this is the moment of **fertilisation**, which in humans is also known as **conception**.
- The nucleus from the sperm, containing chromosomes from father, fuses with the nucleus from the ovum, containing chromosomes from the mother, & a potential new life begins.
- The new cell (known as the **zygote**) has a unique set of chromosomes. If all goes well, it will develop into a baby.

Contraceptive methods and birth control

Contraception:

- Is a method of avoiding conception/pregnancy or controlling fertility by preventing the fusion of the male gamete with female gamete.
- Different contraceptive method are based on different techniques these are
  - Preventing conception
  - Preventing ovulation
  - Preventing implantation
- Major contraceptive method used by people are;

1) NATURAL METHOD of contraception

- Natural birth control method without using hormonal or physical material

a) Rhythm or calendar method

- Contraception based on understanding the menstrual cycle & predict ovulation time.
- Avoid sexual intercourse around the time of ovulation (total abstinence for about 7 days) b/c the life span of the egg is up to 1-3 days after it released from the ovary and the sperm also stayed about 3-4 days after inserted into the uterus.
- Ovulation can be detected by the increase in temperature associated with it, by changes in the vaginal mucus or by using a monitor which detects changes in the chemicals in the urine around ovulation.

Advantage there is no side effect

Disadvantage

- It is not easy to pinpoint ovulation so pregnancy can result
- Depend on full cooperation on both partner

Effectiveness 10 pregnancy per 100 percent

If the menstrual cycle occur every 28 day,

- 28-18=10 (highest number) 10 – 17 pregnancy period
- 28-11=17 (lowest number)

If the menstrual cycle occur every 27 day,

- 27-18=9 (highest number) 9 – 16 pregnancy period
- 27-11=16 (lowest number)

If the menstrual cycle occur every 26 day,

- 26-18=8 (highest number) 8 – 15 pregnancy period
- 26-11=15 (lowest number)

b) Breast feeding

- Delay ovulation and the start of menstruation, because the level of progesterone is high to regulate the feeding breast

c) Withdrawal: penis is withdrawn from vagina b/r ejaculation.

2) PHYSICAL BARRIER METHOD

A. Condoms:

- Prevent ovulation and sperm meeting
- Protect against STD

Advantage

- No side effect
- Do not need medical advice
- Protect against sexually transmitted disease

Disadvantage

- Can interrupt intercourse
- Sheath may tear or damage during sexual intercourse

Effectiveness; 2.5 pregnancies per 100 woman years

B. The diaphragm or cap

- Is a thin rubber inserted into the vagina before intercourse to cover cervix.
- Prevent the entry of sperm on the cervix
- Protect cervical cancer
- Must be initially fitted by a doctor
- 2.5 pregnancy per 100 woman of years

3) HORMONAL METHOD (chemical contraceptive methods)

- Use natural hormone progesterone and estrogen to prevent pregnancy

a) Mixed pill (kiyt enkibil)

- Prevent ripening egg in ovary and prevent ovulation
- Pill is taken at a regular daily interval
- It can cause raised blood pressure and blood cot
- Pill consists estrogen and progesterone;;
- Rises estrogen in the blood results in
  - Pituitary gland slow down the production of follicle stimulating hormone
  - FSH responsible for maturation of egg , if the egg is not mature there is no pregnancy
- Rises of progesterone results in;
  - Increase the mucus in the cervix and vagina to prevent the entrance of sperm cell
- The **most reliable** contraceptive method

b) Mini pill (progesterone only pill)

- Does not contain estrogen
- Does not inhibit ovulation
- Need to be taken precise time interval

c) Hormonal implant

- Involves implanting small silicon capsule contains female hormone implanted under the arm of woman and prevent pregnancy for up to 5 years.
- If a woman wants to become pregnant the implant can be removed
- **Advantage** prevent pregnancy up to five years
- **Disadvantage (side effect)**
  - Changes period
  - Headaches
  - Depression

d) Hormonal injection



- ❖ Prevent pregnancy up to three months
- ❖ Contain female hormone estrogen and progesterone
- ❖ Stops ovulation
- ❖ Changes cervical mucus to prevent sperm getting through
- ❖ Affect the period and headache
- ❖ The users increase by 2kg in each year

5. Sterilization or Surgical Contraception: permanent contraception

a) Vasectomy (male sterilization)

- ❖ Involves cutting and tying of vas deference (sperm duct)
- ❖ Prevent sperm getting into uterus

b) Tubectomy or female sterilization

- ❖ Involves cutting and tying of fallopian tube
- ❖ Prevent the release of egg from ovary to fallopian tube

6. **INTRAUTERINE DEVICE (IUD)**

- ❖ A device made of plastic and copper which is inserted by doctor in the uterus
- ❖ Does not prevent fertilization
- ❖ Prevent implantation
- ❖ Prevent pregnancy up to twelve years
- ❖ If a woman wants to become pregnant the IUD can be removed.

Work sheet

✓ **Choose the best answer (endocrine and reproductive) 10th**

2. w/c of the ff hormone is not correctly paired with its function
   A. thyroxin-regulates metabolism
   B. adrenalin-prepare the body for stressful situation
   C. parathyroid hormone-regulates the development of sex hormone
   D. insulin- regulate the glucose level
3. The hormone involved in the regulation of the blood glucose level are secreted by
   A. pancreases C. thyroid gland C. gonads D. liver
4. The monthly discharge of blood in human female which starts at puberty:
   A. menstruation C. ovulation C. menopause D. fertilization

5. Which of the following is not true about female genital mutilation FGM)
   A. it increase the rate of HIV/AIDS
   B. It leaves scarring so sexual intercourse is painful
   C. it keeps girls pure and necessary for marriage
   D. it has big problem giving birth due to searing
6. Which of the following contraceptive method is grouped with hormonal contraceptive method?
   A. Intrauterine C. Condom C. Norplant D. vasectomy
7. Suppose a girl looked like a boy in her external feature. This situation could be due to the lack of hormone called.
   A. Adrenalin C. Testosterone C. insulin D. Estrogens
8. The gland which produce a hormone that regulate the level of calcium ion in the blood is;.
   A. Adrenal C. thyroid C. parathyroid D, pancreases
9. The endocrine gland which produce at the base of brain is
   A. Parathyroid C. pituitary C. Adrenal D. Thyroid
10. Which of the following contraceptive methods can be used by a human male?
   A. diaphragm B. hormonal injection C. Vasectomy D. Tubectomy
11. Which of the following method is secreted by pituitary gland?
   A. Luteinizing hormone C. parathyroid gland B. progesterone
   D. Thyroxin
12. The hormone whose deficiency results in slow growth and mental development in children;
   A. Luteinizing hormone C. parathyroid gland C. progesterone
   D. Thyroxin

14. What is the cause of diabetes mellitus?
   A. More production of adrenalin by adrenal gland
   B. Less or no production of insulin by pancreases
   C. Less or no production liver by ovary
   D. More production of progesterone by ovary

✓ **Choose the best answer (endocrine and reproductive) 10th**

1) Contraceptive method involves buying of a small silicon capsule containing female hormones under the skin
   A. hormonal implant C. .intrauterine device
   B. hormonal injection D. Mixed pill

2) How hormone able to find target cell?
   A. The gland and the cell are located each other
   B. the cell contain receptor cells specific to the hormone
   C. the hormone are taken to the cell by carrier molecules
   D. the hormones and the cells are made up of identical molecules
3) An increase in the level of insulin in the blood would directly result in;
   A. an increase in the level of carbohydrate in the cell
   B. an increase in the level of carbohydrate in the cell
   C. a decrease in the amount of glucose in the blood
   D. a decrease in the amount of glucose in the blood
4) Which of the following form of birth control does not prevent fertilization?
   A. IUD C. Condom C. diaphragm D. vasectomy
5) Which of the following structure cut and tied of in making male serialization?
   A. penis C. Epididymis
   B. Somniferous tubules D. Vas deference
6) Which of the following hormone cause ovulation?
   A. Oxytocin C. Estrogen C. FSH D. Progesterone
7) Which one of the following does not produce progesterone?
   A. Corpus lutein C. Oviduct C. Adrenal gland. D. Pituitary gland
8) Which of the following two hormones act as antagonistic to one another in regulating blood glucose level?
   A. Thyroxin and insulin C. Adrenalin and progesterone
   B. insulin and Glucagon D. Glucagon and estrogen
9) Which of the following is the correct order of events?
   A. Fertilization → implantation ovulation
   B. Implantation → Fertilization ovulation
   C. Ovulation → Implantation Fertilization
   D. Ovulation → Fertilization Implantation
10) In which part of female reproductive structure fertilization usually occur;
   A. Uterus C. Cervix C. Fallopian tube D. Vagina
11) Which of the following glands would be affected if your kidney is surgically removed?
   A. Parathyroid gland C. Thyroid gland C. Gonads D. Adrenal gland
12) Which of the following deficiency disease is caused the lack of thyroxin hormone in adult human?

A. Cretinism C. Diabetes C. Goiter D. Anemia

13) When there is no pregnancy after ovulation

A. Follicle is formed in the ovary C. progesterone level decrease

B. Oestrogen level increase D. The egg is released from the ovary

✓ **Choose the best answer (nervous and endocrine)**

1. Which part of the brain regulates heart beat?
   A. Medulla C. Hypothalamus C. Cerebrum D. Cerebellum
2. The lobe of brain important in hearing and vision?
   A. Occipital and temporal C. frontal and parental
   B. Temporal and frontal D. Temporal and occipital
3. The most anterior part of human brain is called?
   A. cerebrum C. cerebellum C. spinal cord D. Medulla
4. The nerve impulse that carry impulse to muscle and gland are:
   A. Relay neuron C. Afferent neuron C. efferent neuron D. Spinal cord
5. A person under increase influence of alcohol loses first his ability to think clearly, second his ability to walk, third his ability to breath normally CNS in the order;
   A. Cerebrum . Cerebellum , Medulla C. Cerebrum, Cerebellum, Medulla
   B. Cerebrum, , Medulla, Cerebellum D. Cerebellum , Cerebrum, Medulla
6. Suppose a person holds a very hot object and does not feel a burning pain in his hand. Which of the following neurons are probably damage in his hand:
   A. Sensory C. Motor C. Relay D. Inter neuron
7. Which of the following situation is most probably to produce a reflex action?
   A. Climbing tree C. Seeing a meal
   B. Reading text book D. Writing a latter
8. The axon of afferent neuron is connected to;
   A. Relay neuron C. Muscle fiber C. Motor neuron D. Sensory neuron\
9. The part of brain in charge of thinking and memory:
   A. Cerebrum C. Cerebellum C. Medulla D. spinal cord
10. The part of the body that produce response to stimuli;
    A. Receptor C. Neuron C. Synapse D. Effectors
11. The peripheral nerve system is made up of
    A. Brain and nerve cells C. spinal cord and sensory receptors
    B. Spinal cord and brain D. nerve cells and receptors
12. Which of the following action considered as reflex
    A. Walking C. Drinking C. Breathing D. Sleeping

13. After information is processed in the central nerve systems, instruction are sent to the body by specific neurons which are known as
A. Afferent neurons C. effector neuron C. neurons D. Sensory neurons

13. Which of the following is true about neurotransmitter
A. An electrical event across the membrane of axon
B. An electrical potential on the surface of the entire community
C. A gap whenever one neuron ends and another begins
D. A chemical released when a neuron reaches at a synapses

14. What do we call a change of electrical potential on the surface of a neuron when it is stimulated
A. Resting potential B. Neurotransmitters C. Action potential D. Polarized

15. Effector organ include
A. brain and spinal cord C. Sensory receptors and neurons
B. Receptors and nerve cells D. efferent and afferent neurons

16. Which one of the following is wrong about endocrine or hormonal coordination?
A. Origin of message are receptors C. Message transported through blood
B. Destination of message are effector D. Messages usually have rapid effect

17. One is correctly matched parts of brain and its function?
A. Hypothalamus regulate breathing and circulation
B. Medulla deal with body balance
C. cerebellum regulate hunger and thrust
D. Cerebrum involved in speech intelligence
✓ **Choose the best answer**

Endocrine gland 10th

1. What is the function of thyroxin in human body?
A. Controls metabolic rate of the body
B. control blood glucose concentrations
C. cause the development of embryo in the uterus
D. cause the development of secondary sexual characteristics

2. What is the cause of diabetes mellitus?
A. Less or no production of insulin by pancreases
B. More production of adrenalin by adrenal gland
C. Less or no production of bile by liver
D. More production of progesterone by ovary

3. Which of the following g is true about the function of the gonad?
A. produce hormones of fight and flight
B. control the development of secondary sexual characteristics
C. control the use of oxygen by the body tissue

D. control the metabolic activity of the body

4. Which of the following structures produces hormone
   A. Neuron B. Vessels C. Gland D. Organ
5. Which of the following gland produce luteinizing hormone?
   A. Thyroid B. Pancreases C. Pituitary D. Adrenal
6. Which of the following statements is true about exocrine gland? It
   A. Include pituitary and thyroid gland
   B. Has special tube to carry to carry its secretion
   C. Is ductless and control reproduction
   D. Secret hormone directly into the blood
7. In human body, which hormones are used to control blood glucose level?
   A. Insulin and glucagon C. Thyroxin and glucagon
   B. Testosterone and progesterone D. Adrenalin and glucagon
8. Which of the following is a secondary sexual characteristic of male?
   A. production of ova by ovary C. Breading of shoulder and chest
   B. Development of breast D. Beginning of menstruation
9. Which of the following method is to treat diabetes?
   A. eating red meat C. taking more glucose
   B. taking antibiotics D. insulin injection
10. when there is no pregnancy after ovulation,
   A. follicle is formed in the ovary C. Oestrogen level increase
   B. Progesterone level decrease D. The egg is released from ovary
11. What is the difference between endocrine and exocrine gland?
   Endocrine glands
   A. are more in number in our body then exocrine gland
   B. have duct whereas exocrine glands do not have duct
   C. do not have ducts whereas exocrine gland do have
   D. release their secretion through ducts to site of destination
12. What happen during ovulation in a woman?
   A. The new egg mature in the ovary C. The level of pituitary hormones begin to increase
   B. Follicle forms corpus luteum D. The mature egg is released from the ovary

HIV/AIDS

AIDS:

- is a combination of illnesses that result when the immune system is weakened or destroyed.



- is an infection caused by Human Immunodeficiency Virus (HIV), a virus that attacks the immune system, making the sufferer susceptible to other diseases.

HIV:

- Attacks your immune system so you cannot fight off infections such as TB or even a cold.
- Spread through four bodily fluids (blood, semen, vaginal secretions and breast milk).
- Commonly spread through unprotected sex with an infected partner (without using a condom).
- In Ethiopia more people are infected through heterosexual sex than any other way.
- HIV-infected mother can infect her baby during pregnancy, at birth or through breastfeeding.
- HIV can also be passed on by an infected blood transfusion or by sharing non-sterilised needles, syringes or razors.
- The virus can only spread from an infected person if his/her bodily fluid enter the blood stream of an uninfected person.

Symptoms of HIV/AIDS

- The symptoms of HIV/AIDS are different at different stages of the disease.
- After about three months some people start to feel unwell – early symptoms include
  - Fevers, headaches, tiredness, and
  - Swollen glands, but not everyone infected with HIV feels ill.
  - HIV antibodies appear in your blood – you become HIV-positive
- As the immune system weakens, an infected person may develop more symptoms (relatively mild at first), including
  - Swollen lymph glands,
  - night sweats, fever,
  - cough, diarrhea & weight loss.



- As the disease progresses the symptoms become more noticeable and more severe.
- The symptoms of the final stages of AIDS include:
  - extreme fatigue, rapid weight loss
  - appearance of swollen or tender glands in the neck, armpits or groin
  - shortness of breath, frequently dry cough
  - infections such as TB and pneumonia
  - persistent diarrhea, intermittent high fever
  - appearance of one or more purple spots on the surface of the skin, inside the mouth, anus or nasal passages caused by a rare cancer, Karposi's sarcoma
  - whitish coating on the tongue, throat or vagina as fungal infections take hold
  - forgetfulness, confusion and other signs of mental confusion

The incubation period

- The first symptoms appear 3–12 weeks after you have become infected. This is the initial incubation period of the virus. Before this you can't even detect the infection with a test because your body has not produced enough antibodies.
- In Ethiopia many people will progress from HIV infection to full blown AIDS in 2–3 years, b/C they are already suffering from other diseases or just from a shortage of food.
- During this time the virus reproduces rapidly, infecting the cells of the immune system and destroying them.
- In very healthy, well-fed people with the best medicines available the incubation period is much longer. It can take 20 years or more before all the symptoms of the disease appear.

Treatment

- no cure for HIV/AIDS, and no effective vaccine.



- Antiretroviral medications are used to control the reproduction of the virus and slow the progression of HIV-related disease.
- Some of the early symptoms of HIV can be treated – the secondary infections can be treated with antibiotics, the fungal infections with antifungal drugs and any anaemia with iron and transfusions.
- A healthy lifestyle, with a good balanced diet, regular exercise, no smoking or illegal drug use, and drinking alcohol in moderation if at all can help you to stay well for longer.

Life skills for responsible sexual behaviour

- Using condoms is very effective at reducing the risk of the infection spreading
- Abstinence from extra-marital sex and being faithful within marriage or a relationship is by far the safest option.
- If people avoid the use of substances, such as alcohol, which can affect their judgement
- sterile needles on a regular basis is another way of preventing the spread of HIV/AIDS.
- precautions when handling blood and the body fluids as well as body refuse.
- Girls & young women must insist that their sexual partners use a condom for sex.

Female genital mutilation (FGM) or female genital excision (FGE)

- Locally known as 'removing the dirt'.
- is removing part of the external genitalia of young girls in surgery which is carried out without any anaesthetic, using blades or sharpened obsidian.
- the external genitalia are removed, and the whole region is sewn together leaving a single small opening for the passage of urine and menstrual blood.
- Traditionally people believed that FGM keeps girls pure and is necessary for them to be accepted by men in marriage.



- about 54% of girls in SNNPR experience FGM, 92% in Amhara & up to 100% in Somali.

  Main types of FGM

  1. **Clitterodectomy**
     - Total or partial removal of the external part of clitoris
  2. **Excision**
     - Removal of clitoris and labia partialy/totaly
  3. **Infibulation**
     - Narrowing the vagina by sealing

- FGM puts them at great risk in many different ways.
  - result in serious bleeding and infections which can kill.
  - Increase the HIV infection.
  - When the genital region is sewn closed, girls are at constant risk of infection. This can make them infertile (unable to have children).
  - It can also affect their kidneys and kill them.
  - Sexual intercourse is often very painful for women b/c the FGM leaves much scarring. This does not help them to feel close and loving towards their husbands.
  - It also means that sexual intercourse often causes bleeding on the damaged scar tissue of the genitalia. This makes it very easy for them to become infected with HIV/AIDS if their partner carries the disease.
  - The terrible scarring and narrow vaginal opening often left by FGM means that cut women often have big problems giving birth.
  - The stitching and scarring can tear open, so the woman loses a great deal of blood.
  - Sometimes the baby cannot be delivered alive & and the woman may die.

Review questions

1) In which part of the female reproductive system does fertilisation of the ovum take place?

   A. uterus B. cervix C. fallopian tube D. vagina

2) How long is the average human pregnancy?

   A. 30 weeks B. 35 weeks C. 40 weeks D. 45 weeks

3) Which of the following is NOT a way to help prevent the spread of HIV/AIDS?

   A. Washing your hands after using the toilet. C. having only one sexual partner.

   B. Using a condom when you have sex. D. not sharing needles for intravenous drug use.

Homeostasis

- The nervous and hormonal systems play an enormous role in maintaining internal conditions in a stable state (balance).
- Feedback mechanisms involving both the nervous system and hormonal systems play a very important part in maintaining homeostasis.
- Most of these control systems in the body are examples of negative feedback. This means that when levels of a substance in the body rise, changes are made w/c *lower* the levels again.
- When levels of a substance fall, changes are made so that it *rises* again to the original levels.

Controlling temperature

Heat:

- is a form of energy which is produced in a number of ways including by the sun and by artificial heating systems.
- is also generated by the chemical reactions in the body.

Temperature:

- is a way of measuring hotness or coldness (the effect of heat energy) on a relative scale.
- Is a measure of kinetic energy

- Wherever we go and whatever we do our body temperature is maintained at the temperature (around 37 °C) at which our enzymes work best.
- It is not the temperature at the surface of an organism which matters – the skin temperature can vary enormously without causing harm.
- It is the temperature deep inside the body, known as the internal or core body temperature, which must be kept stable.
- We can get a good measure of our human core body temperature by taking the temperature in the mouth, in the anus or on the surface of the eardrum.
- Living organisms are continually gaining heat from cellular respiration and by conduction, convection and radiation from their surroundings.
- **Conduction**: is the transfer of heat by physical contact
- **Convection**: is the mass movement of air and water molecules
- **Radiation**: is the diffusion of heat from a warm body to a cooler environment.
- They are also constantly losing heat by the evaporation of water from the body surfaces and by conduction, convection and radiation to their surroundings.
- It is the balance of these gains and losses that gives the core temperature.
- Not all animals need to control their core body temperatures.
- Protista and small animals living in big bodies of water like the sea have no means of temperature regulation because they do not need them.
- Larger animals living in many different habitats must be able to regulate their body temperatures so they can avoid cell damage from overheating, but also gain enough heat to have an active way of life.

There are two types of animals based on their body temperature:

a) Poikilotherms (Exothermic animals)

- ❖ animals whose body temperature is governed by the external temperature.
- ❖ They rely largely on the environment for their body heat.
- ❖ Their body temperature can vary according to the environment. E.g., fish, amphibian and reptiles.

b) Homoiotherms (Endothermic animals)

- ❖ animals with a relatively constant internal body temperature which is usually higher than the external temperature. E.g., birds and mammals.

Temperature control in poikilotherms

- ❖ Rely on changes to their behaviour and their body structures to use the heat in their environment to maintain a reasonably steady and useful body temperature.
- ❖ When they are cold they may:
  - ➢ bask in the sun
  - ➢ press their bodies close to a warm surface
  - ➢ erect special sails or areas of skin to absorb more heat from the sun
- ❖ When they are getting too hot they may:
  - ➢ move into the shade
  - ➢ move into water or mud

Temperature control in homoiotherms

A. Physiological (biological) methods of temperature regulation in homoiotherms

1) Sweating

- ❖ Sweat is mainly made up of water, salt & a small amount of nitrogenous waste.
- ❖ When you are hot sweat oozes out of the sweat glands
- ❖ As the water evaporates it cools the skin, taking heat from the body.



- When sweat a lot can affect water & ion balance b/c water & salt are lost in the sweat so need to take more water & ions in through drink or food to replace the water & ions.
- Sweat itself is not cool, and it can only cool you down if it evaporates.
- In hot, humid conditions you may sweat a lot but it won't cool down b/c the water can't evaporate!
- In cold weather, little or no sweat is formed so little heat is lost by evaporation.

2) Vasodilation

- If the body temperature starts to go up, the blood vessels supplying the capillaries in your skin **dilate**, so that more blood flows through the capillaries.
- The skin flushes & more heat is lost through radiation from the surface called vasodilation and it is particularly obvious in pale-skinned people.
- Less blood flows through the slightly deeper vessels in your skin as a result.

3) Panting and licking

- many mammals have thick, furry coats and so cannot evaporate sweat easily from the skin surface even when they are getting hot.
- Some animals, such as dogs and cats, only have sweat glands in small areas of the skin such as the feet.
- to increase the amount of heat lost through evaporation, animals may lick themselves, coating parts of their bodies with saliva which evaporates and cools them down.
- They also pant which allows water to evaporate from the moist surfaces of the mouth & cools them down.

4) Vasoconstriction

- if your core temperature begins to fall the blood vessels which supply your skin capillaries **constrict** (close up) to reduce the flow of blood through the capillaries.

- This reduces the heat lost through the surface of the skin, and makes you look paler.
- This is known as **vasoconstriction** and it works to keep you as warm as possible.
- More blood flows through the deeper blood vessels of your skin as a result.

5) Piloerection (pulling the hairs upright)

- The hair erector muscles contract. In furry animals this pulls the hairs upright, trapping an insulating layer of air which is very effective at conserving heat.
- Our hairs are also pulled upright, but we have so little body hair that it has little or no effect on heat conservation.
- The most obvious effect is that we get goose bumps on our skin – each bump is the contracted muscle pulling on a hair.
- When the core temperature starts to climb, the hair erector muscles which move our body hair all relax and our hair lies very flat against our skin.
- Again in humans this has very little effect, but in hairy animals this reflex action is important because it reduces the layer of insulating air trapped in the fur and so makes it easier to lose heat by convection.

6) Shivering and metabolic responses

- If your core body temperature drops your metabolic rate speeds up, producing more heat energy so your body temperature starts to go up.
- Your liver in particular is involved in this because it is a very large organ which carries out many different metabolic reactions.
- As part of this response you may start to shiver.
- When you shiver your muscles contract rapidly, w/c involves lots of cellular respiration
- This releases some energy as heat which is used to raise the body temperature.

- As you warm up, shivering stops.
- But if your core body temperature starts to rise, the metabolic rate drops so less heat is produced.

7) Fat layer under the skin (subcutaneous fat)

- it is important that homoiotherms only lose or gain heat when they really need to. So under the surface of the skin is an insulating layer of fat.
- This prevents unwanted heat loss. It is particularly noticeable in animals which live in very cold conditions, for example, seals and whales.
- The very thick layer of fat under their skin is known as blubber.
- Like poikilotherms, homoiotherms use behavioural methods to control their internal body temperature..

B. Behavioural methods of temperature regulation in homoiotherms

1) Clothing

- People choose suitable clothes for the weather as we do not have fur or feathers to keep us warm.
- We wear warm clothes when the weather is cold and fewer, cooler clothes when the external temperature is hot.

2) Seeking shade or shelter

- Like many other animals, people look for shade to keep them cool when it is hot and sunny, and look for shelter from cold, wet or windy conditions to help prevent excess heat loss and keep themselves warm, for example, native male rats live underground in burrows all the time in arid deserts.

3) Taking high-calorie food in cold conditions

- We need to use more metabolic energy to keep warm so we eat high-calorie food in cold conditions. Birds and other mammals do the same.

4) Hibernation

- In cold winters, some homoiothermic animals will hibernate.

- They cannot eat enough to keep their body temperature stable through the cold winter, so they sleep through the bad conditions.
- These animals eat a lot and gain a lot of fat before hiding away in a warm nest or burrow and going into a very deep sleep.
- Their metabolic rate falls and so does their body temperature.
- They do not wake up until the warmer weather of spring arrives with more food for them to eat, for example, dormice and hedgehogs in the UK.

5) Aestivation

- In hot countries, some animals 'hibernate' through the hottest weather as they cannot keep their bodies cool enough.
- These animals usually hide themselves underground or under a layer of mud and go into a deep sleep until conditions cool down again, for example, East African land snails can aestivate for up to three years in times of extreme drought.

6) Wallowing or bathing

- By wallowing in mud or bathing in water, the animals cover themselves in water & the water evaporates from the surface of their skin, cooling them down, for example, elephants and pigs.
- Some animals cannot lose enough heat through sweating alone to keep their bodies cool enough in hot weather. This is a particular problem for some larger animals.

7) Burning fires, central heating, air conditioning, etc.

- By burning a fire or turning on the heating we can warm things up and reduce the heat we lose, keeping us warmer.
- Air conditioning is used in some buildings and vehicles to cool the air down if it gets too hot, so the people inside can lose more heat and keep themselves cool.

Controlling the core body temperature

- above or below normal body temperature our enzymes cannot function properly and the reactions in our cells cannot continue and we die.
- all sorts of things can affect your internal body temperature, including heat generated in your muscles during exercise, fevers caused by disease and the external temperature rising or falling.
- Human beings have an internal control mechanism, a system of homeostasis which enables us to lose excess heat if our core temperature starts to rise, yet generate and conserve heat when our core temperature starts to fall.
- Control of the temperature relies on the thermoregulatory centre in the brain. This centre contains receptors which are sensitive to the temperature of the blood flowing through the brain itself.
- Extra information comes from the temperature receptors in the skin, which send impulses to the thermoregulatory centre giving information about the skin temperature.
- These receptors are so sensitive they can detect a difference of as little as 0.5 °C.
- When the **thermoregulatory centre** detects changes in temperature, our first responses are conscious – we put more clothes on, or take clothes off, move outside or light a fire.
- The control of the body temperature is an example of a negative feedback loop.
- The feedback control of the body temperature involves the thermoregulatory centre in the brain and the skin.

When things go wrong

- The homeostatic mechanisms of temperature control in your body usually work very effectively.
- if conditions become too extreme and things go wrong with your temperature control mechanism, the need for this homeostasis quickly becomes very clear indeed.

- when the weather becomes extremely hot and humid, and when people undertake exceptionally challenging physical activity like running a marathon, the normal homeostatic mechanisms may not cope.
- The salt and water balance is destroyed and then the core temperature will rise to dangerous levels. Once this happens people may die.
- if your core body temperature falls too low you suffer from hypothermia.
- In Ethiopia hypothermia can be seen sometimes in new-born infants if they are small and have little body fat, or if they are not dried and wrapped up warm to be cuddled by their mother as soon as possible after birth. In cooler climates such as the UK this silent killer claims around 30 000 lives every year.
- People with hypothermia have greyish-blue, puffy faces and blue lips. Their skin feels very cold to the touch, and they will be drowsy with slurred speech. As it gets worse, they will stop shivering. If the body temperature falls too low the sufferer will become unconscious and may die.
- Smaller people – such as children – have a much bigger surface area to volume ratio than larger people. You lose heat through the surface of your body – so small people lose heat relatively faster than larger people.
- As a result babies, children and small adults are more at risk of becoming too cold than larger people.
- Big people have a greater risk of overheating as their relatively small surface area to volume ratio means they cannot lose large amounts of heat effectively.

Organs of homeostasis

Excretion:

- getting rid of the waste products which could build up in your body and damage your cells – is one of the most important aspects of homeostasis.
- There are two main metabolic waste products which would cause major problems in your body if the levels rise – carbon dioxide and urea.
- Metabolic wastes are materials which are produced by the metabolic processes of life.
- The organs which are involved in getting rid of these metabolic wastes are known as **excretory organs**.
- The main excretory organs in your body are lungs, kidneys and skin.

1) Lungs and homeostasis

- The carbon dioxide produced during cellular respiration is removed from the body via the lungs when you breathe out. So the lungs are not only the site of gas exchange for respiration, they are also an excretory organ removing carbon dioxide waste.
- If the levels of carbon dioxide increase as you exercise, the level is picked up by sensory receptors in your arteries and brain, which send electrical impulses to stimulate the breathing centres in your brain.
- In turn, these send impulses to make you breathe faster and deeper. As a result, the carbon dioxide levels fall. This is picked up by the same receptors and so the stimulation of the breathing centres is reduced, and in turn the breathing rate falls.
- This is an example of a feedback mechanism – as the carbon dioxide levels go up, the breathing rate goes up which makes the carbon dioxide levels fall, so the breathing rate returns to normal as well.

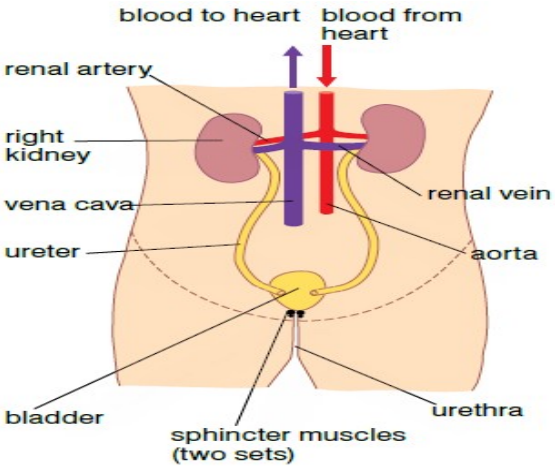
2) Kidneys and homeostasis

- Another metabolic waste which can cause serious problems is urea.
- Urea is produced in your liver when excess amino acids are broken down.



- These excess amino acids come from protein in the food you have eaten and from the breakdown of worn-out body tissue.
- If you eat too much carbohydrate or fat, you can store it (as glycogen or fat) until you need it.
- However, your body cannot store excess protein or amino acids, so any excess is always broken down.
- The amino acids are converted into carbohydrate & ammonia.
- The ammonia is then combined with carbon dioxide (getting rid of another metabolic waste) to make urea.
- The urea which is produced is a form of **nitrogenous waste** and it leaves your liver via the blood.
- The urea is then filtered out of the blood by the kidneys and removed in the urine.
- Kidneys are one of your main excretory organs, and also one of your main organs of homeostasis.
- They play a vital role in the removal of urea from the body, but their role in homeostasis is even more important, because they also play a major part in regulating the water and salt balance of your body.
- If the concentration of the body fluids changes, water will move into or out of the cells by osmosis and they could be damaged or destroyed.
- Yet some days you may drink several litres of liquid and other days much less. How is the balance maintained?
- We lose water constantly from the lungs when we breathe out – water evaporates into the air in the lungs and is breathed out. This water loss is constant.
- Whenever we exercise or get hot we sweat and lose more water. The water balance is maintained by the kidneys.
- Kidneys remove any excess water and it leaves the body as urine.
- If we have too much water then our kidneys produce lots of urine to get rid of the excess.

- The ion concentration of the body – particularly ordinary salt – is also important. We take in mineral ions with our food. Some are lost via our skin when we sweat. Again the kidney is most important in keeping an ion balance.
- Excess mineral ions are removed by the kidneys and lost in the urine. The balance of water and salts in your body is very important because of the osmotic impact on your cells if the balance is wrong so controlling this balance is known as **osmoregulation**.
- kidneys are important in two aspects of homeostasis (excretion & osmoregulation).



How do the kidneys remove urea and control the levels of water and ions in your body?

- The blood is filtered, so fluid containing water, salt, urea, glucose and many other substances is forced out into the kidney tubules.
- Then everything the body needs is taken back (reabsorbed), including all of the sugar and the mineral ions needed by the body.
- Blood flows into the kidney along the renal artery.
- The amount of water reabsorbed depends on the needs of the body.
- The urea and excess ions and water not needed by the body are released as urine.

- Each kidney has a very rich blood supply and is made up of millions of tiny microscopic tubules (nephrons) which are where all the filtering and reabsorption takes place.

A. Bowman's capsule:

- the site of the **ultrafiltration** of the blood. The blood vessel feeding into the capsule is wider than the vessel leaving the capsule, which means the blood in the capillaries is under a lot of pressure.
- Several layers of cells – the wall of the blood capillaries and the wall of the capsule – act as a filter and the blood cells and the large blood proteins cannot leave the blood vessels as they are too big to fit through the gaps.
- However, water, salt, glucose, urea and many other substances are forced out into the start of the tubule – in fact the concentration of substances in the liquid in the capsule is the same as that in the blood itself.
- This process is known as ultrafiltration – filtration on a very small scale.

B. Glomerulus:

- the knot of blood vessels in the Bowman's capsule where the pressure builds up so that ultrafiltration occurs.
- The volume of blood leaving the glomerulus is about 15% less than the blood coming in – which is a measure of the liquid which has moved into the capsule as a result of ultrafiltration.

C. First coiled (convoluted) tubule:

- the liquid which enters this first tubule is known as the **glomerular filtrate**.
- The first tubule is where much of the reabsorption takes place.
- All of the glucose is actively taken back into the blood along with around 67% of the sodium ions and around 80% of the water.
- has many microvilli to increase the surface area for absorption.

D. Loop of Henlé:



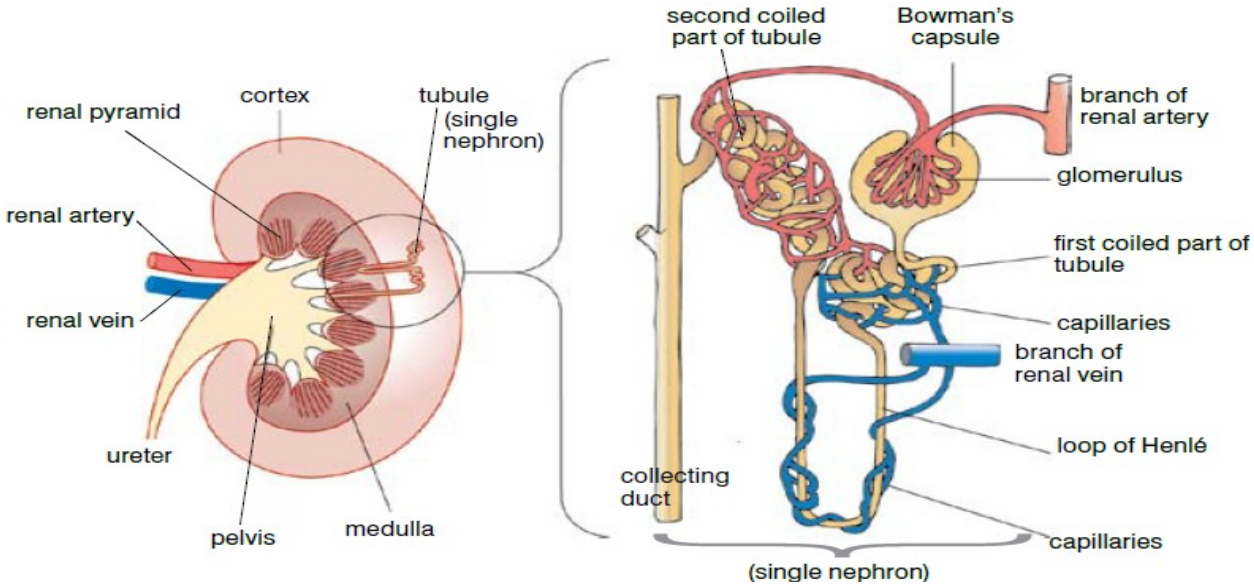
- where the urine is concentrated and more water is conserved.

E. Second coiled (convoluted) tubule:

- where the main water balancing is done. If the body is short of water, more is reabsorbed into the blood in this tubule under the influence of the **anti-diuretic hormone** or **ADH**. (Diuresis means passing urine, so anti-diuresis means preventing or reducing urine flow.)
- Ammonium ions and some drugs (if they have been taken into the body) are secreted from the blood into this tubule to get rid of them.
- By the end of this second coiled tubule all of the salt which is needed by your body has been reabsorbed, leaving the excess in the filtrate along with most of the urea.

F. Collecting duct:

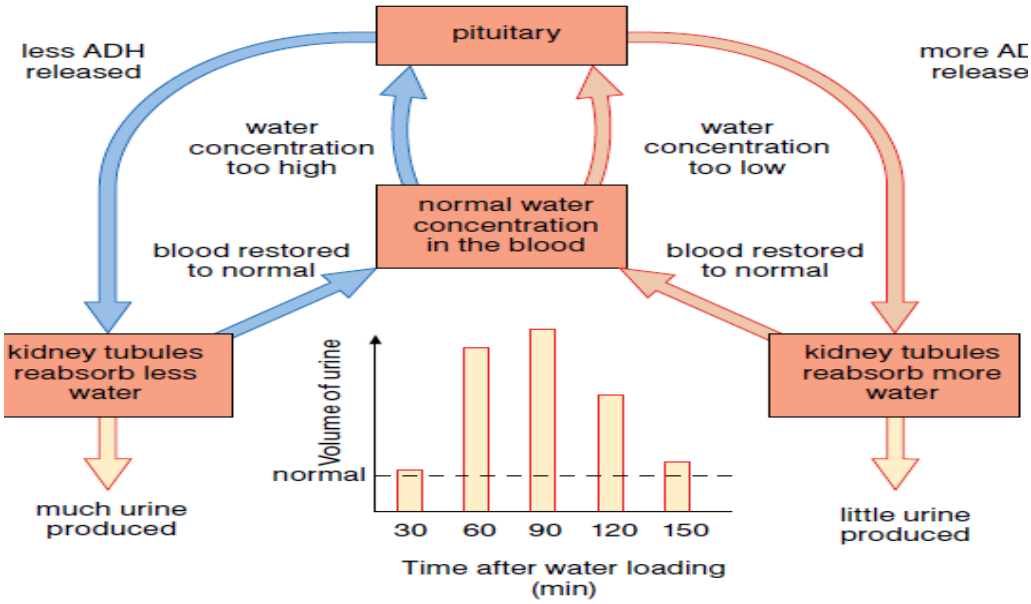
- where the liquid (essentially urine) is collected. It contains about 1% of the original water, with no glucose at all.
- The level of salt in the urine will depend on the amount of salt in your diet and the water content of the urine. There is also a much higher concentration of urea in the urine than in the blood – about 60 times more, in fact.
- But if your body badly needs more water, more may be reabsorbed along the collecting duct – again under the influence of ADH – until the urine passes into the pyramid of the kidney and on into your bladder.



- Urine is formed constantly in your kidneys, and it drips down to collect in your bladder.
- The bladder is a muscular sac which can hold between 600 and 800 cm3 urine, although we usually empty it when it contains only 150–300 cm3.
- We can control the opening of the bladder tanks to a strong ring of muscle known as a **sphincter** at the entrance to our **urethra**, the tube that leads from the bladder to the outside.
- We can open and close this sphincter voluntarily, although it also opens as a reflex action if the bladder is too full – or if we are very frightened!
- When we are young, we have to learn to control our bladder sphincter voluntarily.
- The amount of water lost from the kidney in the urine is controlled by a sensitive feedback mechanism involving the hormone ADH.
- If the water content of the blood is too low (so the salt concentration of blood increases) special sense organs known as **osmoreceptors** in your brain detect this.
- They stimulate the pituitary gland in the brain to release ADH into the blood. This hormone affects the second coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood.



- This means less water is left in the kidney tubules and so a more concentrated urine is formed. At the same time the amount of water in the blood increases and so the concentration of salts in the blood returns to normal.
- If the water content of the blood is too high, the pituitary gland releases much less ADH into the blood. The kidney then reabsorbs less water back into the blood, producing a large volume of dilute urine. Water is effectively lost from the blood and concentration of salts returns to normal.
- This system of osmoregulation is an example of negative feedback.
- As the water concentration of the blood falls, the level of ADH produced rises. Then as the water concentration of the blood rises again, the level of ADH released falls.
- On an average day your kidneys will produce around 180 l (that's about 50 gallons) of liquid filtered out of your blood in the glomerulus (**glomerular filtrate**) – but only about 1.5 l (just over 2.5 pints) of urine. So more than 99% of the liquid filtered out of your blood is eventually returned to it.
- You can observe the way in which your kidney works to maintain water balance in your own body. If you drink a lot of water, you will quickly notice that you need to urinate more often, and that you produce large quantities of very pale coloured, dilute urine.
- If, on the other hand, you are in a situation where you cannot get enough to drink, you will urinate much less frequently and produce a small volume of dark coloured, concentrated urine. This is a very elegant example of homeostasis in action.



3. Skin and homeostasis

- salt and water balance of the body.
- Forms a waterproof layer around the body tissues which protects uncontrolled loss of water from our body tissues by evaporation.
- Prevents from gaining water by osmosis every time you go swimming in the river!
- Loses salt and water through the process of sweating. This can affect the ion and water balance of your body when you sweat a lot.
- Sweating help the body to cool down, not to control the ion and water balance of the body.

4. liver and homeostasis

- The liver also plays a large role in maintaining a constant internal environment.
- It is the largest individual organ in your body – it makes up around 5% of your body mass.
- The liver has a very special blood supply.
- hepatic artery & vein there is another blood vessel w/c comes to the liver directly from gut.
- hepatic portal vein and it brings the products of digestion to the liver to be dealt with.

- A large number of reactions take place in the liver. Many of them are involved in homeostasis in one way or another.
- It plays a part in all of the following functions:
  - Control of the sugar levels in the body (through stored glycogen in the liver itself).
  - Controlling and balancing the fats that you eat and the cholesterol levels in your blood.
  - Protein metabolism – your liver breaks down excess amino acids and forms urea. If you eat more carbohydrate or fat than you need in your diet your body simply stores the excess energy as fat. If you eat too much protein, it isn't so easy. Your body cannot store the excess amino acids or simply convert protein to fat. Instead the amino acids which make up the protein are broken down in your liver. The amino (nitrogen containing) part of the amino acid molecule is removed and converted into ammonia and then urea in the liver. The rest of the amino acid can be used in cellular respiration or converted to fat for storage. The process of removing the amino group from excess amino acids is known as **deamination** and it is a very important function of the liver.
    - **Deamination**: is the removing the nitrogen containing part of the amino acid and changing it to urea w/c is later excrete by the kidney
    - The liver removes the amino group from the amino acid forming a compound called ammonia
    - Amino acid + oxygen → carbohydrate + ammonia
    - Ammonia + CO_2 → Urea
  - The breakdown of worn-out red blood cells – in particular the red pigment haemoglobin.
  - The formation of bile which is made in the liver and stored in the gall bladder before it is released into your gut to emulsify fats and help in their digestion



- Control of toxins – your liver breaks down most of the poisons you take into your body, including alcohol. This is why the liver is so often damaged when people drink heavily.
- Temperature control. Around 500 different reactions take place in the liver at any time.
  - the reactions which generate heat are cancelled out by reactions which use heat, so that in fact the liver produces very little excess heat.

❖ avoid drinking too much alcohol, which can cause cirrhosis of the liver. The liver tissue is destroyed which can eventually kill you.

❖ Heavy drinkers also often develop liver cancer.

Review questions

1) Which of the following is not an example of homeostasis?
   A. control of the blood sugar levels C. control of the water content of the blood
   B. control of the body temperature D. control of the length of the limbs
2) Which of the following areas is NOT part of the nephron (kidney tubule)?
   A. Bowman's capsule B. urinary bladder C. loop of Henlé D. first coiled tubule
3) Which of the following statements is true about ADH?
   A. ADH is a hormone produced in the brain which affects the second coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood and little, concentrated urine is formed.
   B. ADH is a hormone produced in the brain which affects the first coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood.
   C. ADH is a hormone produced in the kidney which affects the coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood.

D. ADH is a hormone produced in the brain which affects the second coiled tubules of the kidneys, making them less permeable so less water is reabsorbed back into the blood and much dilute urine is formed.

4) Here is a jumbled list of the events by which your body temperature is controlled when it starts to go up. Which sequence of events is correct?

I. Tilahun exercises hard and his body temperature starts to rise.

II. Tilahun takes a long, cool drink to replace the liquid he has lost through sweating.

III. His temperature returns to normal.

IV. Tilahun's skin reddens & he sweats heavily so amount of heat lost through his skin goes up.

A. I, II, III, IV B. I, III, IV, II C. I, IV, III, II D. I, III, IV, II

Unit 4

Food making and growth in plants

The leaf

- There are four main organs of a flowering plant.
  1) **Flowers:** contain the reproductive organs.
  2) **Leaves:** make food by photosynthesis using light energy, carbon dioxide and water
  3) **Stem:** provides support & a transport system for water & minerals to the leaves & flowers. It also transports food from the leaves to the roots and flowers.
  4) **Roots:** anchor the plant to the ground and absorb water and minerals.

Photosynthesis

- $H_2O + CO_2 \xrightarrow{\text{light energy/chlorophyll}}$ Glucose $+ O_2 + ATP$
- During photosynthesis light energy from the sun is absorbed by a green substance called chlorophyll that is found in the chloroplasts of some plant cells.

- It takes place in the leaves of plants.
- The energy that is captured is used to convert carbon dioxide from the air and water from the soil into a simple sugar, glucose, with oxygen as a by-product.
- Some of the glucose produced during photosynthesis is used immediately by the cells of the plant for respiration to provide energy for cell functions, growth and reproduction.
- The energy released in respiration is used to build up smaller molecules into bigger molecules:
- Sugars like glucose are built into starch for storage because glucose is soluble and so could affect the water balance within the plant.
  - Sugars like glucose are built into molecules like fructose (fruit sugar) and sucrose (a double sugar unit) to be transported around the plant.
  - Sugars like glucose are built up into more complex carbohydrates like cellulose to make new plant cell walls.
  - Sugars, along with nitrates and other nutrients that the plant takes up from the soil, are used to make amino acids. These amino acids are then built up into proteins to act as enzymes and make up much of the cytoplasm of the cells.
  - Sugars may be built up into fats and oils (lipids) for storage in seeds and to make up part of the cell membranes.
  - Sugars may be used to build up important large molecules such as chlorophyll, using minerals such as magnesium taken up from the soil.
- Starch is insoluble, which means that it does not dissolve, so it has no effect on the concentration of solutions. This means that it can be stored in different places without having any effect on the water balance of the plant.
- Starch is also a very compact molecule, so it takes up relatively little room, and it is easily broken down again into glucose molecules when it is needed by the cells of the plant.

- Iodine solution is reddish brown. In the presence of starch, iodine turns blue-black.
- the waxy cuticle forms a waterproof layer so the iodine cannot penetrate and the green colour could mask a slight colour change. .

Factors needed for photosynthesis

a) The need for light

- Light-dependent reactions cannot take place without light energy.
- Light energy is absorbed by chlorophyll molecules through activation of their electrons
- used to split water molecules into hydrogen and oxygen.
- Adenosine triphosphate (ATP) for energy is produced as well.
- The hydrogen is used in the rest of the process, and the oxygen is given off as a gas.
- It is a waste product of the light reactions of photosynthesis.
- The hydrogen and ATP produced in the light reaction are then used in a series of reduction reactions that convert carbon dioxide into glucose.
- This stage of the process does not need light to take place and is known as the light-independent reaction.
- If plants are deprived of light for any substantial amount of time they will die, because once the stores of starch have been used up they are not replaced and so there is no energy available for the metabolic reactions of the cells.
- The simplest way of demonstrating the need of a plant for light is to deprive it of light and see what happens.
- You can keep a whole plant in the dark for two to three days called **destarching** the plant and then compare the leaves with those from a plant kept in the light.

b) The need for carbon dioxide

- There are lots of carbon-containing chemicals in existence, but carbon dioxide from the air or in solution in water is the only form that plants can use in photosynthesis.
- Carbon dioxide is even produced by the plants themselves as a result of cellular respiration.
- To demonstrating that plants need carbon dioxide for photosynthesis, remove the carbon dioxide from the air surrounding a leaf or a plant using potassium hydroxide, which absorbs CO_2.
- However, the individual plant cells still produce carbon dioxide as they respire and so it is almost impossible to entirely deprive a plant of the gas.
- A more valid approach is to change the levels of carbon dioxide in the air surrounding a plant in high-intensity light and measure the changes in the rate of photosynthesis.
- As the carbon dioxide level increases, the rate of photosynthesis goes up.

c) The need for water

- water is the only source of hydrogen that plants can make glucose.
- Water is vital to all the functions of a plant. This means you cannot demonstrate that water is required for photosynthesis just by depriving the plant of it – the plant would die long before the effect of lack of water on photosynthesis would show.
- The only way to show that water is needed for the process of photosynthesis is to supply the plant with 'heavy' water containing the $_{18}O$ isotope of oxygen.
- These atoms are radioactive, and the radiation they produce can be detected as it is taken up and used by the plant.
- Substances like this are known as **radioactive tracers**. This experiment not only shows that water is needed for photosynthesis, it also makes clear what part the water plays.

- It shows that the oxygen gas produced during photosynthesis comes from the splitting of the water molecules using light energy. This is known as photolysis (splitting using light).

d) The need for chlorophyll

- Capturing the energy from the sun is carried out by the green pigment chlorophyll.
- The simplest way to demonstrate that chlorophyll is needed for photosynthesis to take place is to consider the leaves of a variegated plant.
- Variegated leaves have areas that contain chlorophyll and areas that do not.
- The chlorophyll-free regions are usually yellow or creamy-white in colour.
- If a destarched variegated plant is then exposed to light for several hours and you test one of the leaves for the presence of starch, the iodine solution changes colour only in those regions of the leaf that were green.

Adaptations of a leaf for photosynthesis

1) leaf is flat and wide, giving a large surface area to collect light and short distances for gases to diffuse. The veins bring water from the soil to the cells.

2) waxy cuticle is a waterproof layer found on the surface of leaves to help prevent water loss.

3) The **palisade mesophyll** is the main photosynthetic tissue of the plant.

- There are many cells, closely packed together near the surface of the leaf to get as much light as possible.
- Each cell has many chloroplasts – hundreds of them – which are spread out through the cytoplasm of the cell when light levels are high but which cluster at the top of the cell when light levels are low.

4) The **spongy mesophyll** has fewer cells with fewer chloroplasts.

- However, there are lots of air spaces and a big surface area for gas exchange.

- ❖ Some photosynthesis takes place here but more importantly it is where the carbon dioxide needed for photosynthesis moves into the cells, and the oxygen moves out.
- ❖ The water lost in transpiration evaporates from the cells here as well.

5) The **lower epidermis** has openings known as **stomata** which allow carbon dioxide to diffuse into the leaf and oxygen and water vapour to diffuse out.

- ▸ The **guard cells** open and close to control the entry of carbon dioxide into the leaf and also to control the loss of water by transpiration.
- ▸ The **vascular bundles** contain the **xylem**, dead tissue which brings water from the soil to the cells of the leaves, and the **phloem**, living tissue which carries the products of photosynthesis away from the leaves to all of the cells of the plant.

6) Each **chloroplast** contains stacks of membranes and chlorophyll to give an increased surface area for photosynthesis to take place.

Review questions

1) Which of the following is not an external feature of a leaf?
   A. petiole B. midrib C. chloroplast D. cuticle
2) Which of the following is the tissue where most photosynthesis takes place?
   A. spongy mesophyll B. palisade mesophyll C. epidermis D. stomata
3) Gases move in and out of a plant through:
   A. the cuticle B. the stomata C. the epidermis D. the roots

The importance of photosynthesis

- ❖ the ultimate source of energy for the Earth, the sun – is tapped and converted into chemical energy which is available to life.
- ❖ The organisms that carry out photosynthesis in water may be true plants, algae, phytoplankton, protists and bacteria.

- Scientists are looking hard at ways in which algae might be used as a future source of both human food and fuels to replace fossil fuels.
- Algae grow at a tremendous rate and replace themselves very rapidly. They not only produce biomass very rapidly, they also produce large amounts of oxygen and use up carbon dioxide.
- Photosynthesis is very important as the source of energy for almost all living organisms.
- Almost all living organisms need oxygen for cellular respiration.
- Plants and other photosynthesising organisms remove carbon dioxide from the atmosphere.
- photosynthesis is very important for maintaining the balance of oxygen and carbon dioxide in the atmosphere.
- if carbon dioxide levels build up, this may lead to global warming.

Review questions

1) Iodine is used to test for which substance to show that photosynthesis has taken place in the leaf of a plant?

A. glucose B. cellulose C. protein D. starch

2) Which of the following is not needed for photosynthesis to take place?

A. carbon dioxide B. oxygen C. chlorophyll D. light

3) Photosynthesis is a process that requires a pair of raw materials, a pair of conditions and produces a pair of products. Name the:

i) Pair of raw materials: water and carbon dioxide

ii) Pair of conditions: light energy and chlorophyll

iii) Pair of products: glucose and oxygen

Worksheet

4) Consider the following chemical equation:

$6CO_2 + 6H_2O \quad 6O_2 + C_6H_{12}O_6$

The process involved in this equation is

A. Respiration B. Photosynthesis C. Decomposition D. Metabolism

Transport



- The main transport systems in plants rely on osmosis, diffusion and active transport.
- Trees are obviously supported by their woody trunks. But many plants do not have woody tissue, and so they have no structural support.
- Osmosis is not only vital for keeping the plant cells turgid. It is also very important for moving water around within the plant itself.
- Plants take up water through their roots. The water in the soil has a very low concentration of dissolved minerals.
- Water moves into the plant root cells across the cell membrane along a concentration gradient. The roots are covered with special cells, which have tiny hair-like extensions called the **root hairs**. These root hairs increase the surface area for osmosis to take place. Once water has moved into the root hair cells, the cytoplasm of the root hair cells is more dilute than the cytoplasm of the surrounding cells.
- Water moves into the neighbouring cells by osmosis and the water moves on by osmosis until it reaches the xylem and the transpiration stream.

Active transport in plants

- Plants don't just rely on osmosis and diffusion. Active transport is also widely used in plants. For example, the mineral ions in the soil are usually found in very dilute solutions – more dilute than the solution within the plant cells.
- By using active transport plants can absorb these mineral ions, needed for making proteins, and other important chemicals from the soil, even though it is against a concentration gradient.
- Active transport like this involves the use of energy produced by respiration in the cells.

Transport of materials around the plant

- Plants make food by photosynthesis in the leaves and other green parts

- Water and minerals move into the plant through the roots in the soil, but they are needed by every cell in the body of the plant.
- Plants need a transport system to move substances around their bodies.

A double transport system

- There are two separate transport systems/tissue in plants.

1) Phloem:

- Is made up of living tissue and it is involved in the transport of organic materials – the nutrients made by photosynthesis – from the leaves to the rest of the plant.
- Phloem cells are thin walled and are regularly replaced when they are worn out.
- They contain a liquid rich in sugar.
- When insect pests such as aphids attack plants, they stick their feeding parts into the phloem to suck up the food-rich liquid.
- By depriving much of the plant of food, these pests can destroy crops & cause terrible hardship.
- The plant has to use energy to move substances around the phloem, and food substances can move both up and down the plant.

2) Xylem:

- carries water and mineral ions from the soil around the plant.
- is dead and there is no active transport taking place.
- The movement of the water in the xylem is due to **transpiration** and it is **passive**.
- This means it uses no energy from the plant.
- Water only moves up from the roots to the leaves.
- In woody plants like trees the xylem tissue makes up the bulk of the wood, and the phloem is found in a ring just underneath the bark.
- This makes young trees in particular very vulnerable to damage by animals because, if a complete ring of bark is nibbled, transport in the phloem comes to a complete halt and the tree will die.

The need for transport in plants

- The importance of moving the food made by photosynthesis around the plant is obvious – all the cells need glucose for cellular respiration as well as materials for growth.
- The sugars that are produced in the leaves & carried all around the plant can also be stored.
- plants cannot store sugars, because they have an osmotic effect.
- If a cell had lots of sugar in it, lots of water would move into it by osmosis.
- So sugars are converted into starch, which is osmotically inert. This means that a cell can contain lots of starch and it has no effect on the movement of water by osmosis into or out of the cell.
- The starch stored in plant cells is broken down to sugars again to provide them with energy when the need arises.
- Root tubers, stems and leaves can all be filled with starch to form storage organs. These enable plants to survive difficult conditions and also to reproduce.
- The movement of water and minerals from the roots is just as important as the movement of food.
- The minerals are needed for the production of proteins and other molecules within the cells.
- The water is needed for two main reasons (water is needed for photosynthesis and maintains the turgor pressure within the cells).
- Water moves into plant cells by osmosis. This produces turgor so the cytoplasm presses against the cell walls.
- Turgor pressure in the cells is very dependent on water moving up through the xylem from the soil.
- It is also very important in keeping the leaves firm and spread out to catch the sunlight.

- If the supply of water stops, the whole plant, or just the leaves, will wilt and all the chemical processes of photosynthesis and respiration will be affected.

The transpiration stream

- Water is taken into a plant through the roots and moves by osmosis to the xylem tissue.
- There is no active transport in the xylem.
- The transport of water through a plant is the result of the transpiration stream.
- Plants lose water vapour from the surface of their leaves. This loss of water vapour is known as transpiration.
- Most of the transpiration takes place through the tiny holes in the surface of the leaf known as stomata.
- The stomata allow air containing carbon dioxide into the leaf for photosynthesis.
- They can be opened and closed by the guard cells which surround them.
- Losing water through the stomata is a side effect of opening them to let carbon dioxide in, but it is vital for transpiration.
- Most of the stomata are found on the underside of the leaf.
- What affects the opening and closing of the stomata? This seems to be linked to osmosis.
- Guard cells contain chloroplasts so they can photosynthesise, unlike the other cells in the epidermis layer. So when there is sunlight, the concentration of sugar in the guard cells goes up as a result of photosynthesis.
- Water then moves into the guard cells by osmosis from the epidermal cells around them.
- The sausage-shaped guard cells become very turgid, and as they swell up they bend, opening a gap – the stoma – between them.

- The pore closes by reverse process – water moves out of the guard cells by osmosis into the surrounding cells and as the level of turgor in the guard cells falls, the stoma closes.

Moving water through the plant

- As water evaporates from the surface of the leaves, water is pulled up through the xylem to take its place. This constant moving of water molecules through the xylem from the roots to the leaves is what is known as the transpiration stream.
- What factors move the water upwards?
- There is pressure pushing the water up from the bottom – the root pressure – as water moves in by osmosis.
- In the xylem, two physical forces help the water to move upwards.

1) Adhesive forces:

- B/n the water and walls of the xylem which support the whole column of water.

2) Cohesive forces:

- Between the water molecules.
- the water molecules tend to stick together and get pulled upwards like a string of beads.
- However, the main pull which moves water up from the roots to the leaves is the almost constant evaporation of water from the leaves.
- When water reaches the xylem in the leaves, there is a reversal of the situation in the roots.
- Now the solution in the xylem has a much higher concentration of water than the solution in the mesophyll cells in the leaf.
- Water moves out from the xylem into the mesophyll cells and so across the leaf by osmosis.
- When it reaches a mesophyll cell which is surrounded by air, water evaporates from the surface into the air and diffuses out through the stomata along a concentration gradient.

Factors affecting the role of transpiration



- Because the transpiration stream is driven mainly by the evaporation of water from the leaves, anything which affects the rate of evaporation will affect transpiration.
- Conditions which increase the rate of evaporation also increase the rate of transpiration.
- **Temperature**: The higher the temperature, the more evaporation takes place.
- **Humid air:** Water evaporates more rapidly into dry air than into humid air.
- **Windy**: If the air is moving – it is windy – then water vapour- rich air is always being removed from around the leaf.
- **Light**: Plenty of light also speeds up transpiration. In good light conditions, lots of photosynthesis takes place and so the stomata are opened to allow plenty of carbon dioxide in.
- When the stomata are open, lots more water can evaporate from the surface of the leaves.

Reducing water loss

- If a plant begins to lose water faster than it is replaced by the roots, it runs the risk of wilting. The stomata in the leaves will close to stop this if possible.
- leaves have a waxy, waterproof layer (known as the **cuticle**) to prevent uncontrolled water loss.
- In very hot environments the cuticle may be very thick and shiny.
- The fact that the stomata are on the underside of the leaf

Adaptations of plants to reduce water loss in difficult environments

- Plants manage to grow and survive in many different environments. In many places survival is a real struggle.
- Plants need to balance opening the stomata to allow photosynthesis to take place with the loss of water which takes place when the stomata are open.



- Plants which live in very hot areas like Somali, or in areas where there is relatively little water, often have adaptations which help them to balance up their different needs.
- They may have very thick, waxy cuticles to reduce any water loss through the overall leaf surface to an absolute minimum.
- Others have developed very hairy leaves, which trap a micro-atmosphere around the stomata and reduce water loss. Yet other plants have reduced their leaves to very narrow spikes to reduce the surface area over which water may be lost.
- On some plants the stomata are sunk into pits. Another way of preventing water loss, which you often see in grasses, is for the leaves to be rolled, trapping a micro-environment of moist air inside.
- The purpose of all these adaptations is to reduce the loss of water from the leaves by transpiration, so the plant can photosynthesise and avoid wilting whatever the conditions around it.

Transpiration and agriculture

- Transpiration has many implications for the way we grow our crops – and the crops we choose to grow.
- If our crop plants do not get enough water, then they will not be able to transpire and they will wilt.
- So, whenever possible we need to irrigate our fields and water the plants so that they can transpire fully, which allows them to photosynthesise and grow as much as possible.
- The final way in which transpiration affects agriculture is in our choice of crop plants. Some plants are more resistant to water loss by transpiration than others.
- By choosing crops which are suited to the conditions where we are growing them, we can improve our yields and make sure that transpiration works for us and does not cause our plants to wilt and fail.

Review questions

1) Which of the following conditions will not increase the rate of transpiration in a plant?
   A. high humidity in the air B. windy conditions C. high temperatures D. high light levels
2) Water moves out of plant leaves through the:
   A. epidermis B. mesophyll C. stomata D. chlorophyll
3) Cobalt thiocyanate changes colour in the presence of water. Does it go from:
   A. pink to blue B. blue to pink C. blue to yellow D. pink to white

Response in plants

- All living organisms need to be able to respond to their surroundings. This may be to find food, move towards the light or avoid danger.
- To take in information about the surroundings and then react in the right way is known as co-ordination.
- They need to respond to factors such as light, water and gravity to make sure that they grow the right way up, and that they make as much food by photosynthesis as possible.
- Plants achieve their co-ordination and responsiveness through a system of **hormones**.
- Hormones are chemical messengers which are produced in one part of an organism and have an effect elsewhere.
- Plant hormones (phytohormones) have several effects on plants.
- For example, they co-ordinate flowering, cell division and cell elongation. These are essentially growth processes and plant responses of this type are called growth responses.
- Since growth is a slow process, most plant responses are slow.

The germination of seeds

- In most flowering plants, growth starts when the seed begins to germinate.
- the basic structure of seeds always contains:

a) Endosperm: Food storage tissue

b) Embryo: made up of three main parts

- **plumule** (embryonic shoot)
- ***r*adicle** (embryonic root)
- **Cotyledons** (embryonic leaves).

c) Testa: the seed coat, which may be thin and papery like the covering on a groundnut or very strong and hard like the shell of a nut.

- The number of embryonic leaves that are present which gives us the main division of the angiosperms into monocotyledons (one seed leaf) and dicotyledons (two seed leaves).
- In monocots the main food store is the endosperm and the embryo remains a very small part of the seed.
- In dicots the endosperm moves food into the cotyledons which become the main food store.
- By the time the seed is mature the endosperm has all but disappeared.
- The embryo with its food swollen leaves takes up most of the seed.
- Once the food store has been laid down and the embryo has developed the seed dries out (dehydrates). It loses much of its wet mass and becomes dormant.
- Once a seed is mature and conditions are right – it needs water, warmth and oxygen – the seed begins to germinate.
- To begin with chemical changes take place inside the seed. As the seed absorbs water, the large insoluble food molecules stored in it undergo changes. They are broken down (hydrolysed) into soluble food.
- The main food storage material in seeds is starch, and it is stored either in the cotyledons or in the endosperm. This starch store is converted to sugars by the action of the enzyme diastase. In some seeds fats and oils are stored. In these seeds the enzyme lipase catalyses the hydrolysis of fats to fatty acids and glycerol.
- Proteolytic enzymes present in the seeds catalyse the hydrolysis of proteins to amino acids.

- A lot of energy is needed during germination.
- The seed cannot make its own food by photosynthesis while it is underground, so the energy needed comes from the stored food materials.
- It follows therefore that as a seed germinates its weight decreases as the stored food is used up. The decrease in weight continues until the seedling is capable of photosynthesising.
- The following is a summary of changes which occur during the germination of a bean seed – a dicot seed.

1) The seed absorbs water through the micropyle (small hole) and swells.

2) The testa (seed coat) bursts and the radicle emerges. The radicle continues to elongate and gives rise to many side roots.

3) As the radicle elongates it pushes the seed out of the ground. The curved part of the radicle which protrudes is called the epicotyl. The seed coat is discarded and the two cotyledons (seed leaves) open out and begin to photosynthesise.

4) The plumule emerges from in between the cotyledons and produces the first true leaves. At this stage, the young plant is called a seedling.

Types of germination

1) Epigeal (dicot) germination:

- The curved portion, the **hypocotyl**, pushes through the soil. As germination continues, the hypocotyl straightens and carries the cotyledons and the plumule above the soil surface. This type of germination, where the cotyledons are carried above the soil, is called **epigeal germination**.
- Most dicotyledonous plants have seeds which exhibit epigeal germination. Such seeds include castor oil seeds, groundnuts, cotton and Bambara nuts.
- Epigeal germination also occurs in a few monocotyledonous seeds such as onions and lilies.

2) Hypogeal (monocot) germination

- Germination of a maize grain follows a different pattern from that of a bean seed. The plumule pushes its way out of the soil while the cotyledon remains underground.
- The plumule does not form a hook as in bean seeds. This type of germination in which the cotyledons remain underground is called **hypogeal germination**. Other examples of grains exhibiting hypogeal germination are wheat, sorghum and millet.
- A few dicotyledonous seeds such as kidney beans and broad beans exhibit hypogeal germination.
- Germination of any type can occur only in a seed which is viable. A viable seed is one in which the embryo is alive. The length of time a seed can remain viable varies in different species. Many seeds can remain viable for up to 50 years if properly stored.
- The new roots must grow down into the soil to get the water and minerals the new plant needs.
- The shoot must grow upwards towards the light so that the new shoots can photosynthesise and make as much food as possible so the seedling can grow. How is the direction of growth of plants controlled?

Plant hormones and growth

- Growth in plants is influenced by chemical messengers called plant hormones. Examples of plant hormones are **auxins** (including indole-acetic acid, IAA), **gibberellic acid**, **cytokinin**, **ethylene** and **abscisic acid**.

1) Auxin (IAA)

- Is the best-known plant hormone and it is involved in general plant growth.
- stimulates the elongation of the new plant cells, so they get longer and bigger.
- It is also involved in **apical dominance**.

- IAA is made at the tip of the main shoot and as it moves down the stem it slows down the growth of side shoots. So the main shoot dominates the whole plant.
- If you cut off the growing tip of a plant it will bush out. The side shoots grow quickly once you remove the apical dominance from the auxins produced by the main shoot.
- stimulates the growth of roots. If auxin is applied to a cut stem it will stimulate new roots to grow – this is widely used by gardeners and farmers in some parts of the world to help them take successful cuttings.
- The best-known function of auxins is in the responses of plants to the world around them.
- The responses of plants towards things such as light and gravity are called **tropisms**

2) Gibberellins

- stimulate the growth of plant stems.
- If you take a dwarf plant and give it IAA, nothing much will happen.
- If you give it gibberellins the stems will grow until the plant is a normal size.
- help seeds to break their dormant period and start to grow.
- Stimulating the production of enzymes needed to break down the food stores in the seeds.

3) Cytokinins

- stimulate cell division in plants so they are very important in plant growth.
- The balance between auxins and cytokinins in a tissue culture of plant cells decides whether roots or shoots will grow.

4) Ethylene,

- is a gas hormone at room temperature and it causes fruit to ripen.
- It also causes fruit and leaves to fall from the plant in some species.

5) Abscisic acid (**ABA**)

- It inhibits growth and plays a major role in leaf fall.
- It is also involved in seed dormancy.
- it may be involved in geotropisms, but it plays a small part compared to IAA.

Tropic responses/movement (Tropism):

- Plants need light for photosynthesis, and they grow towards the light.
- When a seed germinates the roots grow downwards and the shoots grow upwards.
- These responses to gravity are vital if the new plant is to be anchored firmly in the soil, and the shoots and leaves held above the ground in the sun.
- Responses to stimuli that come from one direction are known as tropisms.
- Shoots grow towards the light is termed as positive **phototropism**.
- when seedlings are placed horizontally, their roots grow downwards & their shoots upwards.
- Roots of seedlings which were vertically placed continued to grow downwards and their shoots continued to grow upwards.
- Whichever way up you put the seeds the roots grow downwards and the shoots upwards. This suggests that the normal direction of growth of roots downwards and shoots upwards is affected by the force of gravity.
- Movement in response to the stimulus of gravity is called geotropism. Roots are positively geotropic (they grow towards gravity) while shoots are negatively geotropic (they grow away from gravity).
- The response of seedlings to gravity can also be investigated using a piece of apparatus known as a klinostat. This rotates, so by fixing some seedlings to the klinostat in a horizontal position can make sure that gravity acts equally all over the plant.
- You need other seedlings fixed horizontally but not rotated as a control. After two days you can see clearly the effect of the rotation.

- The root keeps bending towards gravity, and the shoot away from gravity, but because the stimulus is not unilateral, due to the klinostat the movements all cancel out and the plants stay straight!
- Light and gravity both have an important effect on the growth of plants.
- Water is also very important so it is not surprising that plants respond to water as well.
- the growth curvature of the radicles was due to the water present in the cotton wool.
- The type of response by which roots grow towards water is termed **hydrotropism**.
- The growth of roots upwards towards water against the force of gravity suggests that water as a stimulus has a greater influence on root growth than gravity.
- In each of the activities, the stimulus has been from one direction (unilateral) and the growth responses have been either towards or away from the source of the stimulus.
- These responses are therefore described as directional responses, tropic responses or tropisms.

How the tropic responses are occurs?

- plants respond to unilateral stimuli.
- Maize grains germinate to produce a straight shoot called a coleoptile.
- Coleoptiles are used in experiments to investigate the role of hormones in shoot growth.
- It is known that the growth region of a shoot is some distance below the tip.
- This fact suggests that removal of the tip would not affect the growth of the shoot.
- when the tips of the coleoptiles are removed (they are decapitated), they don't grow.



- Since the growth of a shoot is promoted by auxins, failure of decapitated seedlings to grow suggests that the auxins are probably produced in the tip.
- It has been found out that the growth hormone, auxin, produced in the tip is **indole-3-acetic acid** (**IAA**).
- IAA diffuses from the tip to the growth region to initiate growth.
- In the decapitated seedlings, although the source of IAA production was removed, the seedling grew for a while and then stopped. This is because some IAA had already diffused away from the tip before decapitation. This amount of IAA was responsible for the slight growth.
- The fact that IAA promotes growth in shoots suggests that it is also involved in the responses of the shoots to light and gravity.
- Shoots lit from one side only also respond by growth – the shaded side grows faster than the illuminated side so the shoot bends over towards the light.
- IAA promotes growth so it seems likely that the shaded side of shoots affected by one-sided light had more IAA than the illuminated side. Since the growth curvature was influenced by light, it suggests that light is somehow involved in the distribution of IAA in the shoot.
- Experiments have shown that IAA diffuses away from light. When a shoot is illuminated on one side, IAA in that side diffuses towards the dark side of the shoot. This causes a build-up of the hormone in the dark side of the shoot.
- Since growth is directly proportional to the amount of IAA, the dark side will grow faster than the illuminated side. This explains the observed growth curvature of shoots shown in the experimental set up.
- The upward growth of the shoot and the downward growth of the root, when the bean seedlings were placed horizontally, involve plant hormones.

- In the shoot, the force of gravity causes an accumulation of IAA on the underside of the plumule. The buildup of IAA on the underside promoted more growth in that region than the upper portion. This differential growth resulted in the stem growing upwards.
- The downward growth of the root is also influenced by IAA, but in the root tip the hormone inhibits growth, rather than stimulating it.
- The force of gravity causes an accumulation of IAA on the underside of the root, resulting in reduced growth in that region.
- The corresponding upper side of the root, which had very little or no IAA, grows faster than the underside. This differential growth results in the downward curvature of the roots.

Nastic responses:

- Plant movements that occur in response to environmental stimuli but unlikely tropic movements, the direction of response is not dependent on the direction of the stimulus. E.g; In most Mimosa pudica plant, when we touch the leaves of the plant they fold up.

Importance of tropic and nastic responses

- In tropisms, some stimuli to which plants respond positively are the basic requirements for the plant's life.
- Water, for example, is one of the important requirements for photosynthesis.
- When positive hydrotropism occurs, roots come into close contact with water to absorb as much water and mineral salts as possible for the plant.
- When a plant responds positively to light its leaves become well exposed to it. This maximises the amount of light available for photosynthesis.

Review questions

1) Which of the following is NOT a tropic response in plants?

A. phototropism B. geotropism C. nitro-tropism D. hydrotropism

2) The young shoots which are often used in experiments on tropisms are known as:

A. coleoptiles B. adventitious roots C. cotyledons D. cornucopia

3) Which of the following is NOT a plant hormone?

A. IAA B. gibberellin C. abscisic acid D. adrenalin

4) The vascular bundles contain:

A. xylem and epidermis C. xylem and phloem

B. B. epidermis and phloem D. stomata and phloem

5) Which tissue contains the most chloroplasts?

A. epidermis B. palisade mesophyll C. spongy mesophyll D. phloem

6) The stomata open and close to allow:

A. carbon dioxide to diffuse into the leaf and oxygen and water vapour to diffuse out of it

B. oxygen to diffuse into the leaf and carbon dioxide and water vapour to diffuse out of it

C. water vapour to diffuse into the leaf and carbon dioxide and oxygen to diffuse out of it

D. carbon dioxide, oxygen and water vapour to diffuse into the Leaf

7) Which of the following is the correct equation for photosynthesis:

A. carbon dioxide + oxygen [+ chlorophyll + light energy]→ glucose + water

B. oxygen + water [+ chlorophyll + light energy] → glucose + carbon dioxide

C. carbon dioxide [+ chlorophyll + light energy] → glucose + oxygen + water

D. carbon dioxide + water [+ chlorophyll + light energy] → glucose + oxygen

8) The glucose made during photosynthesis is converted into which compound to be stored?

A. fat B. starch C. cellulose D. protein

9) Water is split to provide hydrogen to make glucose and oxygen as a waste product during:

A. the light-dependent reaction of photosynthesis C. the trapping of light by chlorophyll

B. the light-independent reaction of photosynthesis D. none of the above

10) Water is taken up through the roots of plants by a process known as:

A. diffusion B. osmosis C. active transport D. evaporation

11) Farmers need to irrigate their fields to replace water b/c plants constantly lose water through:

A. osmosis B. photosynthesis C. transpiration D. diffusion

12) Which of the following is not an adaptation used by some plants to reduce water loss?

A. thick waxy cuticle C. leaves reduced to thin spines

B. stomata on underside of the leaf sunk into pits D. stomata on upper surface of the leaf

13) Which of the following statements are correct?

I. shoots are positively phototropic but negatively geotropic

II. Roots are positively hydrotropic but negatively geotropic

III. Roots are positively hydrotropic and geotropic

IV. Shoots are negatively hydrotropic but roots are negatively phototropic

A. I, II and III B. I, III and IV C. I, II and IV D. II, III and IV

14) Which of these plant responses are not controlled directly by simple plant hormones?

A. shoots bending towards the light C. roots bending towards gravity

B. fruit falling when ripe D. the time of year a plant flowers



Conservation of Natural Resources

Natural resources:

- Anything that is found naturally & useful to human beings.
- Ethiopia has gold, platinum, potash, limestone, natural gas, coal & hydropower, animals & plants.
- Natural resources can be classified as either **renewable** or **nonrenewable**.

Renewable resources

- are mainly living things & their products.
- can be used, reused & replaced.
- E.g; crop plants, trees, cattle & chickens.

Non-renewable resources

- are not living, and when they are used they cannot be replaced.
- include metals like gold & iron and fossil fuels like gas, coal and oil.

Review questions

1) Which of the following is a non-renewable resource?

   A. timber B. gold C. coffee D. khat

2) Which of the following is a renewable resource?

   A. oil B. coal C. gas D. wood

Biodiversity

- is a measure of the wealth of species in a given place.
- is measured just as the number of species in a given area at a particular time.
- is measured as the number of species breeding in an area at a particular time.
- Includes everything from the smallest microbe to the largest animal.

Importance of biodiversity

- To maintain the natural balance.
- To purify air and water.
- To decompose & remove wastes.

- To stabilise the atmosphere and world climate by plant photosynthesis.
- Plant pollination, seed dispersal, soil fertility and the nitrogen cycle are all needed for natural ecosystems and for farming.
- It gives us the genetic diversity we need to develop crops to grow in different conditions.
- as a source of medicines, clothing, food and other useful things for people.
- Huge fields with a single crop (called **monocultures**) are not attractive to look at and they do not support a wide range of other animals and plants.
- If biodiversity is low, the organisms are much more likely to be attacked by disease as it will spread from one to another very quickly.
- Climate change, pollution and human activities have reduced biodiversity.

Review questions

1. A monoculture is:
   A. a field containing a single crop C. a country with only one type of person in it
   B. a clone D. an environment with a rich diversity of species

Vegetation

- Collection of plant species in a particular area.

Using of plants

- for food, for example, teff, sorghum, anchote and beans.
- to make drinks such as tella, and coffee (bunna).
- for building materials
- export timber such as blue gum (bahir zaf) logs as construction material.
- We use vegetation to make clothing – cotton and hemp

- source of medicines; E.g; 'yedega abalo' has been used for centuries to treat dysentery and koso is a medicinal plant that gets rid of worms.
- Trees provide the building material for many boats.
- provide us with fuel when we burn wood or use biofuels.

Endemic species

- Ethiopia is internationally recognised for its rich diversity of plant species.
- We have around 7000 d/t species of higher plants alone, with up to 800 **endemic** species.
- An endemic species is an organism that is only found in a particular area – so we have around 800 endemic plants which grow wild in parts of Ethiopia.
- our endemic species include teff (*Eragrostis teff*), many *Euphorbia* spps, noug or niger seed (*Guizotia abyssinica*), enset (*Ensete ventricosum*), *Ficus vasta* Forssk, zigba, juniper (tid), kererro and sembo trees and many other species.

The history of Ethiopian vegetation

- Emperor Zera Yakob (1434–1468) is said to have organised the collection of the seeds of many indigenous trees such as juniper (tid), olive (woira) and podo (zigba) from the Wof-Washa forest near Debre Sina.
- He had them planted on the Menagesha Mountain. The Menagesha forest is still one of the best preserved in the whole country.
- In 1895 Emperor Menelik II ordered the introduction of bahir zaf (blue gum) to try and replace the native vegetation that was disappearing around many settlements.

Review questions

1) Which of the following is not an endemic Ethiopian plant?

   A. tid B. zigba C. teff D. maize

2) Which of the following is not a use of vegetation in Ethiopia?



A. building material B. fuel C. car building D. medicine

Wildlife

- ❖ is any undomesticated or uncultivated organisms such as birds, reptiles, fish, insects, etc
- ❖ We have 242 mammalian species range from huge elephants to tiny elephant shrews.
- ❖ There are around 862 species of birds as well.
- ❖ Insects are another important aspect of Ethiopian wildlife too.
- ❖ The wildlife acts as pollinators for our flowering plants and helps to disperse the seeds.
- ❖ Our bees provide the honey for a thriving export business and for the production of tej.
- ❖ The balance of wildlife in different regions helps to maintain the natural balance of the plants as well, with predators keeping down the numbers of herbivores so that they do not destroy all the vegetation.
- ❖ Some of the wildlife acts as a genetic bank for our domestic animals and can be used as a source of genetic diversity.
- ❖ one of the most important uses of wildlife in Ethiopia is to generate income from tourism.
- ❖ From our birds of prey to our pelicans and flamingos, from our parrots to the rare white-winged flufftail, people come to Ethiopia for our rich diversity of birds alone.

Endemic species

Ethiopia has number of endemic species of different types of wildlife.

- ✓ 28 species of mammals, which include the Gelada Baboon, the Walia ibex, Menelik's Bushbuck, the Mountain Nyala, Swayne's Hartebeest and the Ethiopian wolf.
- ✓ 31 Endemic bird species include the heavy-headed, thick-billed raven, the wattled ibis, the blackwinged lovebird, the white-collared pigeon and the Prince Ruspolis Turaco.

- ✓ We also have 6 endemic reptiles, 4 fish and around 33 endemic amphibians.

Human effect on wildlife

- ❖ The deforestation which has deprived our country of so much plant biodiversity has also caused many species to be pushed to the verge of extinction.
- ❖ At the moment our Institute of Biodiversity Conservation (the IBC) is warning that at least four mammal species and two bird species are on the brink of extinction as a result of habitat loss.
- ❖ These are the Walia ibex (there are only about 514 left), Mountain Nyala, Ethiopian wolves and Grevy's zebras, while the white-winged flufftail and the Ankober Serin bird are also badly threatened.

Conservation areas of wildlife

- ❖ Conservation is the protection and preservation of our natural environment.
- ❖ Conservation involves protecting habitats & managing populations.
- ❖ Involves preventing the spread of disease.
- ❖ We have set up & maintain a number of national parks & sanctuaries to conserve wildlife.

A. National Park:

- ❖ Is a relatively large area of land which is owned by the Government.
- ❖ No human settlement and hunting allowed
- ❖ Random access to people is not allowed
- ❖ More restricted area
- ❖ Has defined boundary
- ❖ Ticket or permission are required to enter the area
- ❖ Is specifically designed to protect both plants & animals.
- ❖ is protected legally & there should be staff (rangers) who manage & protect environment.
- ❖ Visitors can enter the National Parks under carefully controlled conditions for educational, cultural and leisure reasons.

- Hunting licences may be issued to raise money to help support the park.
- The main National Parks & wildlife sanctuaries have been set up to protect specific species in Ethiopia.

1) Abijatta-Shalla Lakes National Park

- is 200 km south of Addis Ababa and it is 887 km2 in size.
- Animals which are found in this park include flamingos, Great White Pelicans, Grant's Gazelle, Oribi Warthog and Golden Jackals.

2) Awash National Park

- found east of Addis Ababa and its southern boundary is formed by the Awash river.
- The park is relatively dry, with lots of grassland and acacia woodland.
- There are Beisa oryx, Soemmerrings Gazelle, wild pigs. Zebra, dik-dik, Anubis and Hamadryas Baboons, cheetahs, serval and leopards.
- The birdlife is also extravagant and varied, including ostriches, Secretary Birds, Carmine Bee-eaters and the Abyssinian Roller.

3) Bale Mountain National Park

- contains rare Gelada Baboon, Mountain Nyala and Ethiopian wolves.
- Other species found there include the Giant Mole Rat, Klipspringer, Menelik's Bushbuck and warthogs.

4) Gambela National Park

- Nile perch, crocodiles and hippos as well as waterbuck, Roan Antelope, hyena, lions, elephants, buffalo, zebra, Vervet Monkeys and black-and-white colobus monkeys.

5) Rift Valley Lakes National Park

- is in a chain of seven lakes which run from Debre Zeit towards Kenya.
- have Grant's Gazelle and warthogs, but the wildlife for which it is famous is the birdlife, which includes Greater and Lesser Flamingos, a huge colony of Great White Pelicans, fish eagles, spoonbills, Abdim's Storks and ibises.

6) Mago National Park

- Found south-west of Addis Ababa on the east bank of the Omo river,
- giraffe, elephants, lions, buffalo, cheetah, zebra, leopard, rare Black Rhinos & Vultures

7) Omo National Park

- Have kudu, hartebeest, oryx, Anubis Baboons, lions, cheetahs, buffalo, giraffes & elephants.

8) Nechisar National Park

- is between two lakes, Abaya and Chamo.
- Contain Red-billed Hornbills, fish eagles, the Abyssinian Ground-hornbill & the Kori Bustard!
- include crocodiles, Burchell's Zebra, bushbucks, Grey Duiker, Grant's Gazelle & Greater Kudu.
- is very important for the conservation of the rare, endemic Swayne's Hartebeest.

9) Simien Mountains National Park

- is home to both spectacular scenery and spectacular and rare wildlife.
- This major mountain range has been declared a World Heritage Site, and it has many peaks above 4000 m.
- You can find Walia ibex, Ethiopian wolves and Gelada Baboons

10) Yangudi Rassa National Park

- is big and is found in the arid northern Rift lowlands.
- There is a wide variety of vegetation, from semi-desert and scrubland to savannah and even open woodlands.
- you can find the wild-ass ancestor of our domestic donkeys, and Greater and Lesser Kudu, Grevy's Zebra and cheetah.

B. Wildlife sanctuaries:

- Are established for especial protection of species that are considered as endangered, vulnerable & rare
- Owned by the government or private agency
- Is specifically designed to protect animals.
- Is not very restricted area



- Open to general public
- Ticket or permission are not required to visit the area
- Does not have specific boundary
- are similar to National Parks but focus on the conservation of particular species.

1) Harar Wildlife Sanctuary

- Found in Misraq Hararghe Zone of the Oromia region
- set up to conserve and protect our native elephant sub-species, *Loxodonta Africana oleansie* & black-maned lion.

2) Kuni-Muktar Mountain Nyala Sanctuary

- Set up to protect the Mountain Nyala (*Tragelaphus nyala*), an extremely rare endemic animal in Ethiopia.

3) Senkelle Swayne's Hartebeest Sanctuary

- is close to the Lake Rift Valley National Park and it is dedicated to the protection of this rare hartebeest.
- On a large scale we have National Parks and wildlife sanctuaries.
- On a smaller scale many individuals and villages are working to conserve environment.

Review questions

1) Which of the following is not an example of endemic Ethiopian wildlife?
   A. Ethiopian wolf B. cheetah C. Walia ibex D. white-winged flufftail
2) Which of the following is a sanctuary rather than a National Park in Ethiopia?
   A. Bale B. Gambala C. Senkelle D. Simien

Worksheet

3) Which one of the following is not in situ conservation of biodiversity?
   A. Biosphere reserves B. Sanctuary C. Botanical garden D. National parks

Air Pollution:



- is the contamination of the natural environment (air) by harmful substances as a result of human activities.

Pollutant

- is something that contaminates the air, soil and water.

Air pollution

- One type of air pollution is **smoke** produced by burning fuel for energy.
- Fossil fuels such as coal, oil or gas contain chemicals known as **hydrocarbons**.
- When these fuels are burnt, tiny **particles** of unburnt hydrocarbons are released into the air.
- The particles are very small pieces of matter. This type of pollution is sometimes referred to as 'black carbon' pollution.
- The exhaust from burning fuels in cars, homes and industries is a major source of pollution in the air.
- Even the burning of wood on our fires can release significant quantities of soot into the air causing local air pollution. Smoke pollution worldwide is thought to be causing **global dimming**, blocking out some of the light from the sun.
- Another major cause of air pollution is the production of **carbon dioxide**.
- Carbon dioxide is also produced as a result of burning wood and fossil fuels.

Why is carbon dioxide increasing?

- burning huge amounts of fossil fuels in cars, planes and also in power stations to generate electricity.
- Carbon dioxide in the atmosphere is important because of the greenhouse effect.
- It traps some of the heat from the sun and keeps the surface of the Earth warm enough for life as we know it.



- build-up of carbon dioxide gas in the atmosphere causing global warming.
- Deforestation increases the amount of carbon dioxide released into the atmosphere as burning the trees leads to an increase in carbon dioxide levels from combustion.
- The dead vegetation left behind decays as it is attacked by decomposing micro-organisms, which releases more carbon dioxide.
- trees and other plants use carbon dioxide in photosynthesis.
- They take it from the air and it gets locked up in plant material like wood for years. So when we destroy trees we lose a vital carbon dioxide 'sink'.
- Dead trees don't take carbon dioxide out of the atmosphere.
- Methane is another greenhouse gas that causes air pollution and the levels of this gas are rising too. It has two major sources.
- As rice grows in swampy conditions, known as paddy fields, methane is released.
- Rice is the staple diet of many countries so as the population of the world has grown so has the farming of rice.
- The other source of methane is cattle. Cows produce methane during their digestive processes and release it at regular intervals.
- In recent years the number of cattle raised to produce cheap meat for fast food like burgers has grown enormously, and so the levels of methane in the atmosphere are rising.

Global warming

- as a result of human activities the amount of carbon dioxide (and methane) in the air is continuing to increase. This build-up acts like a blanket and traps heat close to the surface of our Earth. This causes the temperature at the surface of the Earth to rise.
- air pollutant is **carbon monoxide**, also produced by the burning of fossil fuels.

- Carbon monoxide is very dangerous because it combines irreversibly with haemoglobin in your blood, reducing the oxygen carrying capacity.
- There is carbon monoxide in cigarette smoke, which is why it is so dangerous to smoke if you are pregnant because you can deprive your unborn baby of oxygen.
- Carbon monoxide poisoning can eventually lead to death b/c the gas has no colour or smell.

Acid rain

- Acid rain is the result of air pollution.
- Fossil fuels often contain sulphur impurities. When these burn they react with oxygen to form sulphur dioxide gas.
- At high temperatures, for example, in car engines, nitrogen oxides are also released into the atmosphere.
- **Sulphur dioxide** and **nitrogen oxides** pollute the air and can cause serious breathing problems for people if the concentration gets too high.
- They form a haze of pollution known as smog,
- They are also involved in the formation of acid rain.
- The sulphur dioxide and nitrogen oxides dissolve in the rain and react with oxygen in the air to form dilute sulphuric acid and nitric acid. This makes the rain more acidic – it is known as **acid rain**.

The effect of acid rain

- acid rain has a damaging effect on the environment.
- damage trees.
- As acid rain falls into lakes, rivers and streams the water in them becomes acidic.
- If the concentration of acid gets too high, plants and animals can no longer survive.
- Many lakes and streams have become dead, no longer able to support life.

- The weak acid attacks the material of buildings and statues, reacting with any calcium carbonate (limestone or marble) and even with metals.
- Firstly, the temperature of the seas is going up as a result of global warming. Just a small rise is enough to kill off the algae on which the coral polyps feed, and so in turn the polyps die and the coral reefs begin to bleach and die as well.
- Secondly, acid rain falls into the sea and the change in pH affects the calcium salts dissolved in the water and breaks down the coral skeleton itself. Without the coral, many of the unique reef ecosystems of the world will be destroyed forever – so controlling air pollution is very important indeed.

Air pollution in our homes

- Some pollutants can be created by indoor activities such as smoking and cooking.
- One particular problem is air pollution in the home from the use of paraffin lamps to give us light in the evening.
- Burning paraffin produces many poisonous chemicals in the air including benzene, carbon monoxide and lead from the wick as well as particles of soot.
- Air pollution can affect our health with both short term and long-term effects. E.g.,
  - Short-term effects:
    - ✓ Irritation to eyes, nose, throat & upper respiratory infections such as bronchitis & pneumonia.
    - ✓ Other symptoms can include headaches, nausea and allergic reactions.
  - Long-term health effects:
    - ✓ chronic respiratory disease, lung cancer, heart disease and even damage to the brain, nerves, liver or kidneys.

Ozone hole (ozone depletion):



- ozone is a gas which is found in the atmosphere of the Earth.
- absorbs some of the ultraviolet radiation from the sun.
- Ultraviolet radiation damages & burns the skin & can cause the skin cancers & eye problems.
- The ozone layer protects life on Earth from the worst of this damage.
- CFCs (chlorofluorocarbons) that used in fridges and freezers as a refrigerant can damage the ozone layer.
- Air pollution by CFCs had caused the ozone layer around the Earth to get thinner, particularly over the Antarctic at certain times of the year.
- This thin area is often referred to as the 'ozone hole'.
- Car exhausts contain carbon dioxide, carbon monoxide, sulphur dioxide & oxides of nitrogen.

Air pollution in Ethiopia

- vehicles
- fuels such as wood or animal dung.
- Burning forests.

Review questions

1) Which of these chemicals has caused the formation of the 'ozone hole'?
   A. sulphur dioxide B. carbon dioxide C. CFCs D. nitrogen oxides
2) Which air pollutants can lead to global warming?
   A. carbon dioxide and carbon monoxide C. methane and sulphur dioxide
   B. carbon dioxide and methane D. methane and nitrogen oxides
3) Which of the following is a non-renewable resource?
   A. eggs B. teff C. sweet potato D. oil
4) Which of the following is a renewable resource?
   A. gold B. coal C. meat D. gas
5) Which of these statements describes conservation?



A. Farming an area intensively.

B. The protection and preservation of our natural environment.

C. The rapid loss of habitats. D. None of the above.

6) Which of the following statements does not explain why biodiversity is important?

A. Biodiversity produces genetic variety. C. Biodiversity reduces the spread of disease.

B. Biodiversity maintains the balance of ecosystem. D. Biodiversity establishes a monoculture.

7) Which of these is not an example of how humans can affect the natural vegetation?

A. classification B. deforestation C. burning D. farming

8) Which of these is not a way of conserving our natural vegetation?

A. protecting natural habitats C. farming sustainably

B. replanting endemic species D. slash and burn deforestation

9) Which of the following is not an endemic Ethiopian species of animal?

A. Mountain Nyala B. Ethiopian wolves C. Gelada Baboon D. Roan Antelope

10) Which of these methods is not an effective way of conserving wildlife?

A. setting up National Parks C. controlling hunting

B. intensive farming D. restoring lost habitat

11) Which of these pollutants causes most problems in Ethiopian homes?

A. sulphur dioxide B. carbon dioxide C. benzene, lead and soot D. nitrogen oxides

12) What damage has been caused by CFCs?

A. global warming B. thinning of the ozone layer C. acid rain D. global dimming

Thank you