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Unit 1
Biotechnology

1.1 What is biotechnology?

- **Biotechnology** is use of micro-organisms to make things that people want.
  Traditional application of Biotechnology
    - Making and preserving foods
    - Making alcoholic drinks. Such as beers, wines,
    - Making bread, and injera
    - Making cheese and yoghurt.
      Modern applications of biotechnology include
    - Using **genetic engineering** to change crops and animals;
    - Producing new medicines
    - To provide new energy sources.
  - Biotechnology is based on **microbiology**.
  - **Microbiology** deal about **micro-organisms** and their effect on humans
  - Micro-organisms are tiny living organisms including bacteria, viruses, fungi and protoctistans,
  - The main groups micro-organism used in biotechnology are **bacteria** and **fungi,** although viruses are being used in genetic engineering.
- **Bacteria**
  - Are single-celled organisms
  - Much smaller than the smallest plant and animal cells.,
  - They can reproduce very quickly.
- **Viruses**
  - Smaller than bacteria.
  - They do not carry out any of the normal functions of living things.
- **Molds and yeasts (fungi)**
  - Living organisms which obtain their food from other dead or living organisms.
  - **Yeasts** are single- celled organisms,
  - **Molds** are made up of thin, thread-like structures called hyphae

Traditional application of biotechnology

1. **Traditional technology using yeast**
   - Yeast cell has a nucleus, cytoplasm and cell wall (surrounded membrane)
   - Yeasts reproduce by asexual by **budding** – splitting into two, to form new yeast cells.
   - **In a plenty of oxygen, yeast respire aerobically**,
     - Breaking down sugar to provide energy for the cells

- Producing **water** and **carbon dioxide** as waste products.
- **Carbon dioxide** produce is important in **making bread and injera**

❖ **In the absence of oxygen yeasts respire anaerobically.**

- Yeast cells in the absence of oxygen, produce **ethanol** and **carbon dioxide.**
- Allowing yeast cells to grow and reproduce.
- The anaerobic respiration of yeast is referred as **alcoholic fermentation**.
- Aerobic respiration provides more energy than anaerobic respiration.

☝ **Injera needs yeast**

❖ At first the yeast respires **aerobically**, produces carbon dioxide,

❖ **Carbon dioxide produced used for**

- Giving injera a **tangy flavour.**
- Its bubbles of gas expand in the high temperature,
- Giving **injera its typical texture,** this is so good for soaking up the food.

☝ **Making alcoholic drinks**

❖ In the absence of oxygen yeasts respire anaerobically

- Produce **ethanol** and **carbon dioxide**
- **Ethanol** produce used for making of alcoholic drinks such as tej, tella, beer, wine

❖ **Tej making**

- Tej need **honey**, water and gesho leaf or gesho stick.
- Gesho gives a bitter edge to the brew
- The yeasts use **honey** as a source of food and respire anaerobically,
- Produces ethanol and carbon dioxide.

❖ **Wine making**

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

2. Food production using bacteria

☝ **Making yoghurt (irgo)**

❖ Traditionally, **yoghurt is formed** by the action of **bacteria** on the lactose (milk sugar).

❖ The bacteria converted lactose into lactic acid. This is known as **lactic fermentation**.

❖ Lactic acid gives the yoghurt it's;

- **Sharp, tangy** taste.
- The milk to clot and **solidify** into yoghurt.
- Make yoghurt a smooth, thick texture.

- Yoghurt- forming bacteria prevent the growth of other bacteria which makes milk bad.
- In Ethiopia, traditionally sticks such as olive tree burned intro yoghurt. Which is used;
  - giving the yoghurt a **pleasant flavor**
  - **Disinfects the vessel** so that only good bacteria grow in the milk

- **Cheese making (ayib)**
  - Cheese formed by action of bacteria
  - Bacteria **changing the texture and taste** of the mɪɪĸ.
  - Cheese making is very successful in preserving milk.
  - The bacteria in cheese convert lactose to 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
- **To sum up** some traditional application of biotechnologies are;–
  - Brewing,
  - Win making,
  - Bread making and
  - The production of yoghurt and cheese

1.2 New applications of biotechnology

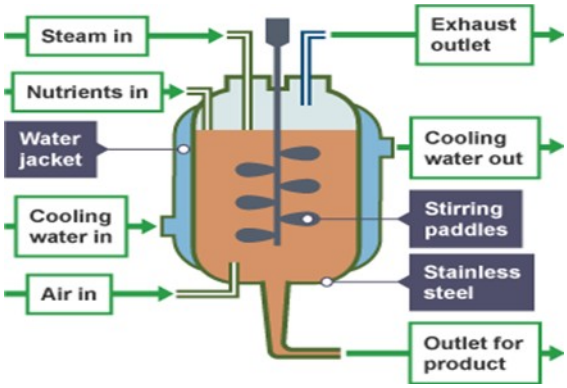
- The new application of biotechnology involves the following major area.
  - Agriculture
  - Food industry
  - Medicine
  - Energy
- One of the most important areas of biotechnology is genetic engineering.

What 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**) or **viruses** are used to transfer genetic information between different organisms
- Genetic material carries the instructions for a new organism, found in the nucleus of every cell.
- For example insulin production;

Figure 1; industrial fermenter



The technology

- Growing large numbers of micro-organisms on an industrial scale in large vessels, known as **fermenters. Industrial fermenters usually have:**

FEATURE	FUNCTION
➢ **An oxygen supply**	to provide oxygen for respiration by the micro-organism
➢ **Stirrer**	Keep the micro-organisms distributed evenly through the culture.

➢ **A water-cooled jacket**	keeps the temperature inside constant
➢ **Nutrient inlet**	Allow sterile nutrient inter the fermenter
➢ **Steam inlet**	Sterile inside of the fermenter
➢ **Measuring instruments**	for continuous monitoring of factors such as pH

Applications of biotechnology in agriculture

- ❖ **Plant cells do not** plasmids
- ❖ **Use Agro bacteriumtumefaciens**
  - ❖ Using genetic engineering, we can introduce new variety of plants and animals.

☝ **Engineered genes** (engineered genes a new gene added into an organism) can be used;

- ➢ To improve the growth rates of plants and animals.
- ➢ Used to improve the food value of crops.
- ➢ Used to make crop plants that are resistant to drought and to disease,
- ➢ To produce plants that makes their own pesticide chemicals.

❖ However, there are **some possible problems** with the new biotechnologies,

- ➢ Produce pesticide-resistant insects
- ➢ Genetically modified plants and animals might spread into new genes into wildlife.
- ➢ Genetically modified crops are often not fertile, which means farmers have to buy new seed each year.
- ➢ E IA R and A A U, scientists are analyzing the genes of many of our most important crop plants, including teff.
- ➢ E IA R is using modern biotechnology to improve teff, coffee, fruit plants and some of our forest trees.

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 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 **mycoprotein.** Which is low in fat content and preferred by vegetarians
- ❖ One of the biggest changes is that enzymes are produced by genetically engineered bacteria.
- ❖ Biotechnology plays a big part in food production.
- ❖ Biotechnology create a completely new food.
  E.g. Mycoprotein (protein from fungi Fusarium)
  For many years people used selective breading to change livestock and crops.
  Characteristics people want
  - ➢ **As big grains**
  - ➢ **Resistance to diseases**
  - ➢ **Plenty of milk**
  - ➢ **Resistant to drought**

Applications of biotechnology in medicine

- ❖ Biotechnology is extremely important in modern medicine.
- ➢ It is used to develop vaccines and antibiotic.
- ➢ The first antibiotic in microbiology was penicillin.
- ➢ Introduce by Alexandor Fleming from fungi ***penicillium notatum***
- ➢ Engendered 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 **hemophilia**.

Applications of biotechnology in energy production

i. Biogas

What is biogas?

- ❖ Biogas is a flammable mixture of gases, formed when bacteria break down plant material, or waste products of animals, in anaerobic conditions.
- ❖ Methane the main component of biogas
  `

- ❖ Table 1.1 The components of biogas

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

Biofuels (ethanol)

- Ethanol-based fuels are sugar-rich products from **sugar cane** and **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 without any problems at all.

- **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.**
    - **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

Unit 2
Heredity

2.1 Mitosis and meiosis

- **Heredity** is the transmission of trait or characteristics from parent to offspring.
  - The science that study heredity or inheritance are called **genetics**
  - The nucleus of every cell contains thread-like structures called **chromosomes**, where the genetic information passed from parent to child.
  - Chromosome is a structure in the nucleus of a cell consisting of genes.
  - **Chromosomes** are made up of **DNA (deoxyribonucleic acid)** and **protein histon**
  - DNA is chemical carries the instructions needed to make all the proteins in cells.

- DNA is the genetic material contained in the nucleus.

❖ Different type of organism has a different number of chromosomes in the cells .E.g.
- Humans have **46 (23 pair)** chromosomes an
- Tomatoes have **24 (12 pair)** chromosomes
- Elephants have **56 (28 pair)** chromosomes

❖ 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 and
- 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 pairs,** are known as the **autosomes**
- Autosomes are the same size and shape,
- Do not determine a boy or a girl.

❖ The remaining **one pair** of chromosomes are known as the **sex chromosomes**
- Determine maleness or femaleness, 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 in human**
- Everyone inherits an X chromosome from their mother.
- If it is fertilized by a sperm carrying X chromosome, you will be a girl.
- If it is fertilized by a sperm carrying a Y chromosome, you will be a boy.
- X chromosomes carry information about being female,
  - ✓ but also carry information about many other things – like
  - ✓ the way of **blood clots,**
  - ✓ The formation of **teeth, body hair and sweat glands**.
- Y chromosomes mainly carry information about maleness.

Chromosomes, Genes and DNA

☝ **Chromosomes**

❖ Chromosomes are strand of DNA carrying genetic information

❖ Composed of DNA and protein histone

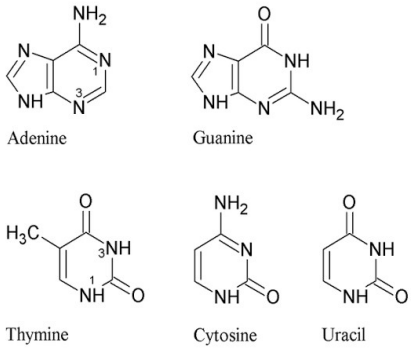
- homologous chromosomes are a pair of chromosomes having the same gene sequences, each derived from one parent

☝ **Gene**

- **Gene** is a **unit of hereditary material** located on the chromosomes
- Genes are repeating patterns of bases in the DNA
- 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
- DNA is a long molecule, made up of two strands twisted together to make a spiral known as a double helix.

☝ **Deoxyribonucleic acid (DNA)**

- DNA nucleic acid containing the genetic instructions used in the development and functioning of all known living organisms and some viruses
- **DNA molecule** is made up of lots of smaller molecules **(nucleotides)** joined together.
- DNA is a polynucleotide chain.
- 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 and thymine **pyrimidine** are whereas guanine and adenine are **purine.**
- DNA molecule has twisted double helix st
- The two DNA strands are linked by base
  - Adenine pairs with thymine (A---T)
  - Cytosine pairs with guanine.(G---C)
  - In DNA the sum of **A+G=T+C** , **A+C=**
  - The number or percentage of **A=T**
- The strands are made of **deoxyribose sugar** and **phosphate**.

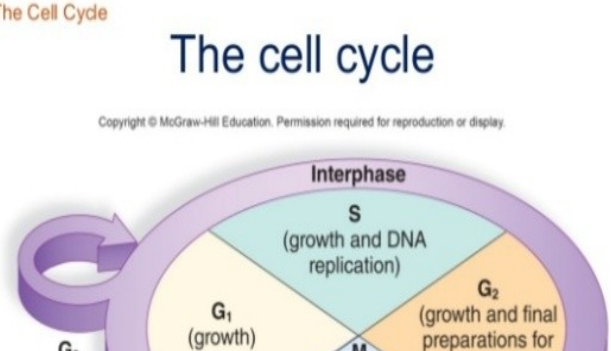


☝ **EXERCISE**

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 thyme

The cell cycle

- cell cycle is the a sequence events which occurs between one cell division and the next
- Which involves three different st



1. **Interphase** (G1, S and G2)
   - A long period of non-division –
   - Preparing the cell for division

- A period of growth(G1 and G2) and synthesis (S)
- Replication of DNA ready for the next division.

2. **Mitosis**
   - A period of active cell division.
   - Division of the nucleus (karykinesis)
3. **Cytokinesis**—division of the cytoplasm

☝ ***There are two main type of cell division***
Mitosis 2) Meiosis

1. **MITOSIS—replication division**
   - A cell nuclei divides to produce **two daughter nuclei**
   - The daughter nuclei contain **identical sets of chromosomes** as in parent cell
   - It occurs in somatic or body cell
   - It helps in growth , replacement and repair of warn out cells
   - A method of asexual reproduction in unicellular organism
   - It is divided into four phases

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

II. Metaphase
- Sister chromatids line up along the equatorial plane of the cell

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

IV. 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 genetic information
  - It gives genetic stability with in a population

- Growth and cell replacement
- Regeneration and asexual reproduction

2. MEIOSIS-reduction division

It is a division

- Occur in reproductive organ namely ovary and testes
- Result in genetically different **4 daughter cells** per division
- Each having half the chromosome number of the original cell
- Important in production of gametes (sperm and egg cell)
- Responsible for the transmission of hereditary information from generation to generation
- the type of cell division that creates egg and sperm cells
- It involve two successive division

Meiosis I

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

Phases of meiosis

- **Meiosis I**

Prophase I –

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

Metaphase I

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

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

Telophase I

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

- **Meiosis II**

- No doubling of chromosome
- Separation of sister chromatid
- Production of four haploid cell

Prophase II

- ❖ The chromosome lie in two polar nuclei
- ❖ Nuclear membrane and nucleus disappear

Metaphase II

- ❖ new spindles are formed and the chromosomes, still made up of pairs of sister chromatids, line up on the metaphase plate

Anaphase II –

- ❖ The centromeres now divide and the sister chromatids move to the opposite ends of the cell

Telophase II

- ❖ Nuclear envelopes reform, the chromosomes return to their interphase state,
- ❖ **Cytokinesis** occurs, giving four daughter cells each with half the chromosome number of the original diploid cell

☝ **Crossing over during meiosis increase genetic diversity**

- ❖ **Crossing over:** exchange of chromosome segments between homologous chromosome during prophase of meiosis
- ❖ Result in new combination of gene



Pairing of homologous ***Exchange of chromosome*** ***New combination of***

Gametogenesis—production of male and fema

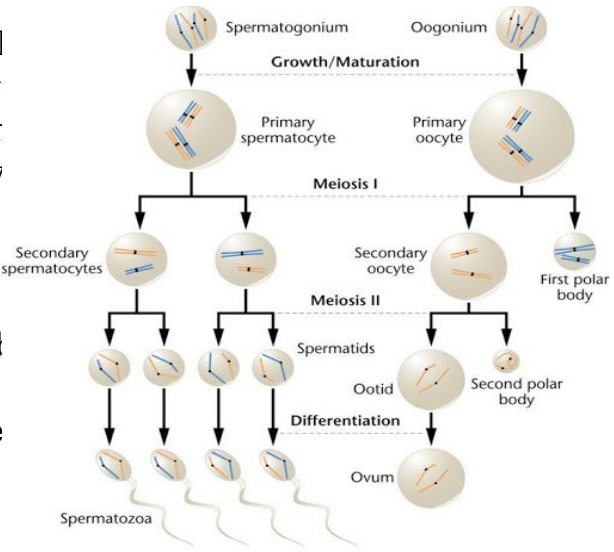
☝ **Oogenesis—**occur in ovaries of females

- ❖ The first stage of meiosis is completed l
- ❖ Baby girl contain all the ova she will ev
- ❖ The second meiotic division occur durir
- ❖ Only one large ova(egg) produce per cy
- ❖ **Oogenesis:** Stops at menopause

☝ **Spermatogenesis—**occur in taste of males

- ❖ The production of sperm
- ❖ In males, meiosis doesn't start until pul
- ❖ Carries throughout a man's life.
- ❖ 4 spermatid (sperm) produce per cycle
- ❖ Each gametes genetically deferent

Spermatogenesis



1. **How *many mitotic divisions are needed for a single cell to make 64 cells?***

A. 8 ***C.9*** ***C. 6***

D. 7

***Solution 2^n* cell produce**

n=number of division

=2^8=256, 2^9=512, 2^6 =64, 2^7=128

=6cycle are needed to produce 64 cells

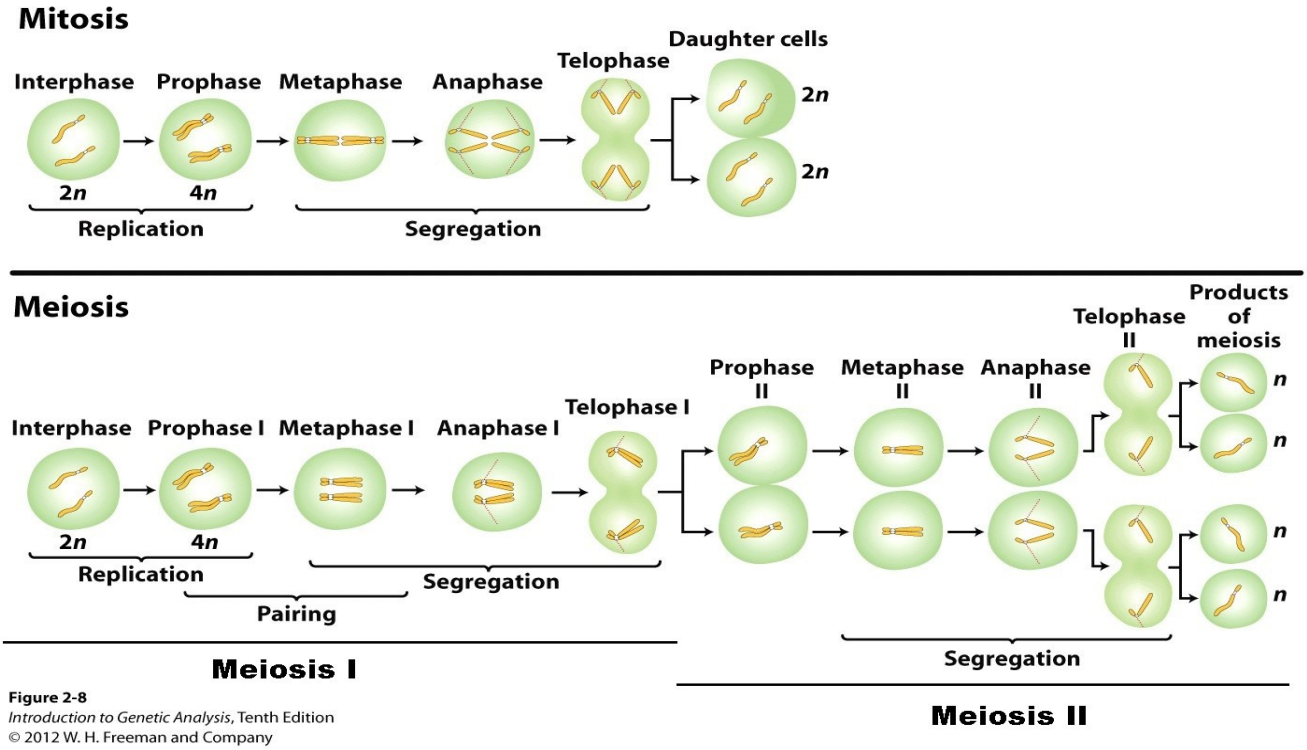


Figure 2-8
Introduction to Genetic Analysis, Tenth Edition
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☝ Comparison of mitosis and meiosis

MITOSIS	MEIOSIS
❖ Take place in somatic cell	❖ Take place in germ (sex) sell
❖ Occur in both sexually and asexually reproduction organism	❖ Occur only in sexually reproduction organism
❖ One division	❖ Two division
❖ 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
- Chromosome number the same as the parent
- No pairing of homologous chromosome

- Daughter cell genetically deferent because of crossing over
- Chromosome number reduce by half of original
- Pairing of homologous chromosome

2.2 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 (mixed) 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
  - 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 use 7 pair of contrasting traits listed below

Specific traits	**Contrasting traits**	
	dominant	**Recessive**
Stem length	Tall	Short
Pod color	Green	Yellow
Pod shape	Inflated (Smooth)	Constricted (pinched)
Seed shape	Round	Wrinkled
Seed color	Yellow	Green
Flower position	Axial	Terminal
Flower color	Red	White

- **Important terms**

- **Alleles** different forms of the same gene
- **Homozygous;** has **the same or identical allele of gene** on each of the chromosomes in the homologous pair .E.g. TT. tt
- **Heterozygous**; has **different alleles of gene** on each of the chromosomes in the homologous pair. E.g. Tt, Yy
- **Genotype**; describes the pair of alleles for a particular gene possessed by a organism. E.g.TT, Tt, Yy
- **Phenotype**; describes traits determined by a particular **genotype** E.g. tall, short, yellow seed. wrinkled seed,
- **Dominant allele** is the allele expressed in a heterozygous organism
  - 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 expressed in the phenotype only if two copies of the allele are present.
  - represented by small later short plant(t),green seed (y)

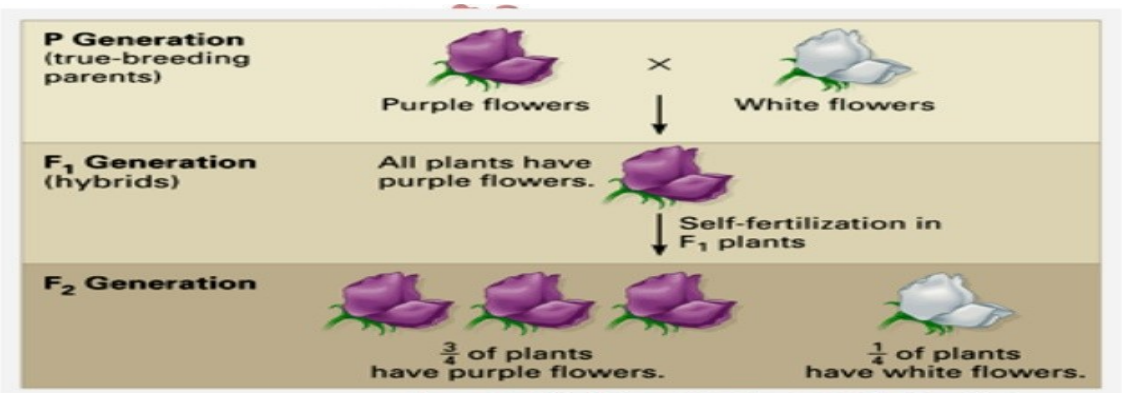
☝ **Mendel experiment on monohybrid inheritance**

☝ **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 **Parental 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 1

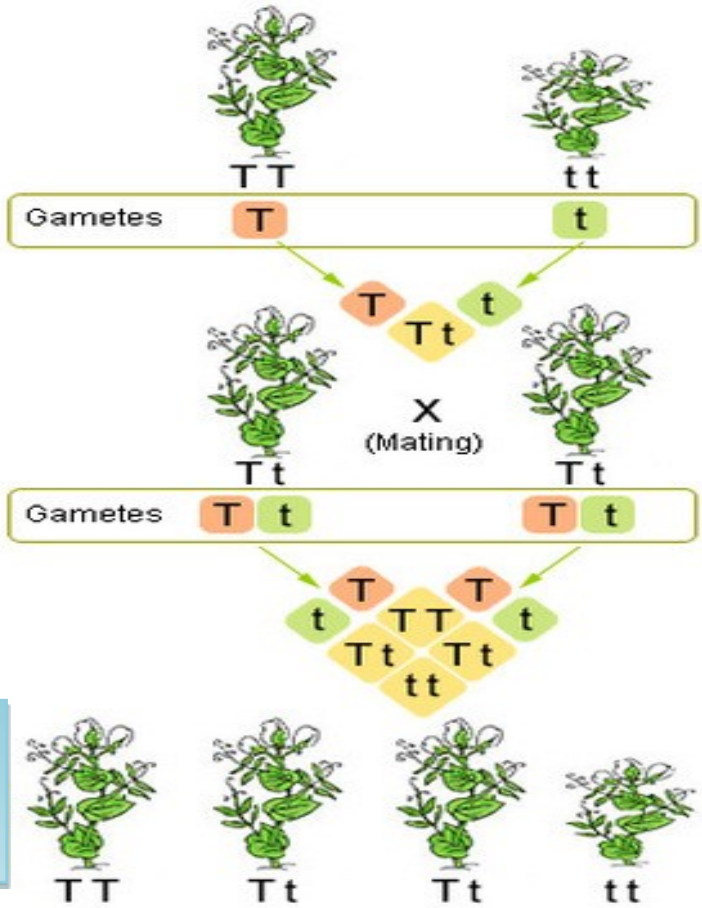


Because of the purple flower trait completely masks the white flower trait when true breeding plants crossed, the purple flower is called

Parental generation

F1 generation
Genotype: All are Tt
Phenotype: All are tall

F2 generation
Genotype: TT, Tt, tt =1:2:1
Phenotype: Tall: Short = 3:1



Mendel conclusion from his discover

- Heredity determined by **factors** which today called **gene**
- Each trait determine by a pair of factors
- One factor comes from each parents
- 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 different traits segregate independently during gamete formation.
  - The traits transmitted to offspring independently of one another

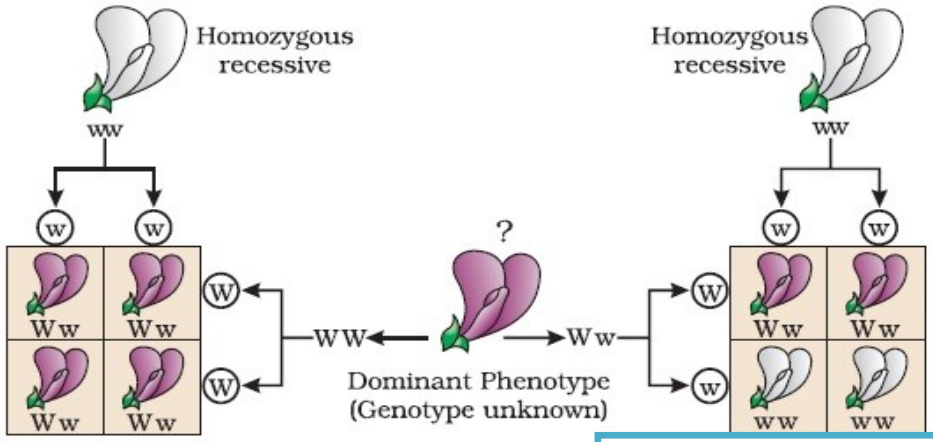
- Example the inheritance of tall plant seed is independent of yellow color seed

Test cross

- A breeding experiment important to determine the genotype of an organism with a dominate phenotype
- The organism is crossed with a homozygous recessive organism
- If all of the offspring shows a dominate phenotype the organism is homozygous dominant
- If it produce 1:1 ratio of dominant and recessive phenotype the organism is heterozygous organism

Example

Note
W=Purple
w=White



Result Interpretati

All flowers are purple
Genotypically unknown

Half flowers are purple and half flowers are white 1:1 ratio
Genotypically unknown flower



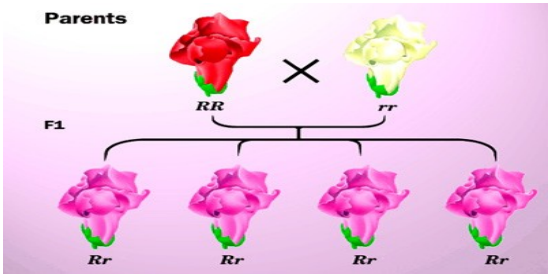
Complete dominan



Coodomin ant

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 expresses their gene product equally on the offspring
   - ➢ **Example. Cattle fur color, ABO blood group**



Phenotype of parents Red bull x White cow

Genotype of parents RR x rr

Gametes R R r r

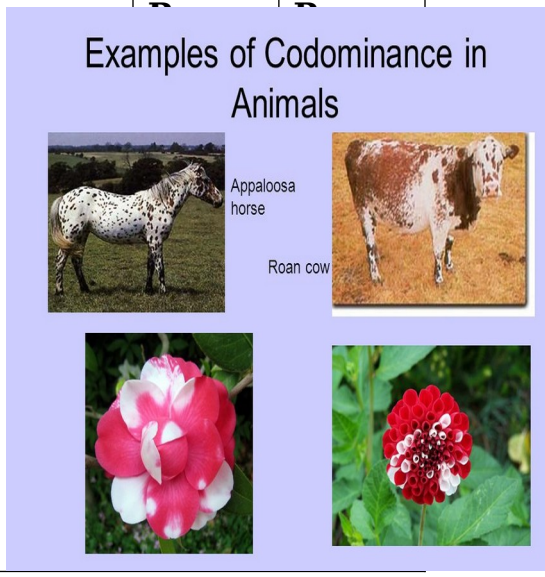
- ✓ F1 genotype: Rr
- ✓ F1 phenotype: roan

Exercise

1. **Roan X white**
2. **Roan X red**

A. Cattle fur color

	R	R
r	Rr	Rr



B. ABO blood group of human

- ❖ Human blood type is controlled by A, B and O alleles
- ❖ Allele A and B coodominant
- ❖ Allele O is recessive

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

☝ **Example**

1. Suppose a **man with blood type O** marries 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

Man

Women

	O	O
B	BO	BO
B	BO	BO

Women

	O	O
B	BO	BO
O	OO	OO

- **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

Man

- **Phenotype women type AB, genotype AB**
- **Phenotype of man type O, genotype OO**
- **So the Children have blood type**

Woman

	A	B
O	AO	BO
O	AO	BO

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 trait are

TRAITS	DOMINANT	RECESSIVE
Dampens	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	**D d**	**dd**
d	**D d**	**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)
  - ***Both couple hybrid dimple***
    - ***Answer***
      - ***Phenotype dimple***
      - ***Genotype***

Father

Mother		***D***	***d***
	D	***DD***	***Dd***
	d	***Dd***	***dd***

- Genotype of children pure dimple, 2 hybrid dimple Dd and 1 non dimple dd **1:2;1**
- Phenotype of children 3dimple, 1no dimple (3;1 ratio)

2. **Ear lobe; *dangly, D***
Attached, d

- **If both of the couple have hybrid dangly ear lobe, How many % of children have dandily**
  Answer.
  - Father; Phenotype no dimple, Genotype Dd
  - Mother; phenotype dimple, Genotype Dd

Father

Mother

	D	**d**
D	**D D**	**Dd**
d	**D d**	**dd**

- Genotype of children 2Dd and **1 attached dd** **1dangly DD**, .hybrid dangly (**genotype ratio 1;2;1**)
- Phenotype of children **3dangly ear lobe, 1 attached ear lobe (3;1ratio)**
- Therefore **75% dangly** ear lobe **and 25% attached**

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 produce an albino child?** **can**

Father

Answer.

- Phenotype of the **both albino**
- Genotype of the parents Aa

	A	**a**
A	**AA**	**Aa**
a	**Aa**	**aa**

Mother

- Genotype of children **1pure normal AA**, **2 hybrid normal Aa** and **1albino aa** (genotype 1**;2;1ratio**)
- phenotype of children **3 normal, 1albino (3;1ratio)**
- Therefore **75% of the normal** but **25%** of albino child

Exercise

- Father heterozygous normal and mother an albino
- **Answer**
  - **Phenotype father heterozygous normal and mother albino**
  - **Genotype** Father Aa and mother aa
  - Gametes A and a a and

	A	a
a	Aa	a a
a	Aa	a a

Phenotype ratio 50% normal and 50% albino
Genotype ratio 50 % hybrid Aa and 50% aa

Father pure normal and mother an albino

- **Answer**
  - **Phenotype father normal and mother albino**
  - **Genotype** Father AA and mother aa
  - Gametes A and A a and a

	A	A
a	Aa	Aa

Phenotype ratio 100% normal
Genotype ratio 100% hybrid

a	Aa	Aa

1. An allele for dangly earlobes (D) is dominant over attached ear lobes; a woman 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 C. DD and Dd C.DD and dd D. Dd and dd

Solution

- Phenotype of a parent woman dangly man attached
- Genotype women DD or Dd man dd

Woman

Man		D	D
	d	Dd	Dd
	d	Dd	Dd

Woman

Man		D	d
	d	Dd	dd
	d	Dd	dd

- **So the possible genotype of the parent is Dd and dd**
- **Breeding** is the process of genetic modification of plant and animals
- It is largely important in for agriculture for breeding of farm animals and crops

☝ **Selective breeding**

- It is a technique of breeding crop plant and animal with desirable trait.
- For Selective breeding 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 recessive characteristic select, 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 needs 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 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** it is breeding of two close relatives can eventually lead to genetic weakness.
- For example a **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.
- ❖ Take an example.

Family one herd goat	***Family two herd goat***
❖ ***Give good milk but not resistant heat***	❖ ***Give less milk resistant to heat***

  - ➢ If both families selected their best male and female goats, and cross-bred,
  - ➢ The offspring would be **good milk production** and **heat resistance gene**.
- ❖ Farmers often simply continue to cross-breed to get the benefits of each F1 generation.

☝ **Importance of breeding for society**

Selective breeding used to maintain

- ➢ To create the best possible performance in our local breeds
- ➢ People will gain the biggest possible benefit from them.
- ➢ They will get the best possible yield from their crops,
- ➢ The most milk from their cows, sheep, goats or camels,

Importance of 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

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.

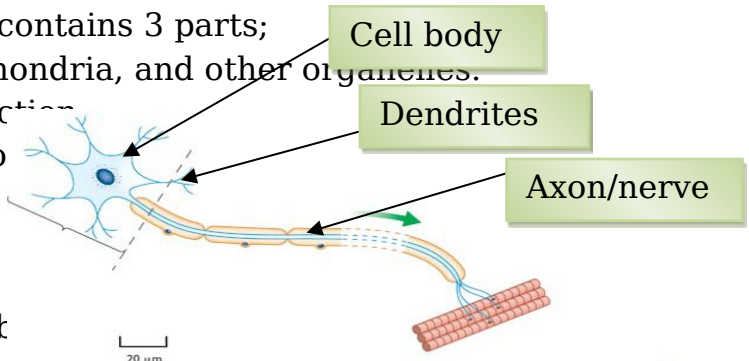
Nervous system	**Endocrine /hormonal/ System**
➢ It use a nervous coordination system	➢ It is chemical coordination
➢ Messages travel fast through nerve cell	➢ Hormone transported through blood

➢ Messages usually have rapid effect	➢ Often take longer to have an effect.•
➢ Usually a short-lived response	➢ Provide a quick response
➢ Origin of message are receptors	➢ Origin of message are endocrine gland
➢ Destination of message are effector	➢ Destination of message are target cell

- **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.**
    - PNS 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) process information coming from sensory receptors
  - **Effectors** (Muscle and Gland), the part of the body which give response to stimuli.

Neurons (nerve cell)

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



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

2) Dendrites slender finger-like projection

- Receive impulse and conduct to
- Join one neuron with other

3) axon (nerve fiber)

- long and thin carry nerve fiber
- Carry impulses away from cell b
- The axon membrane changes its permeability to sodium ions to create an electrical impulse

- **Myelin sheath** provides a layer of insulating material so the nerve impulse travels as fast as possible.
- **Synapse** is the junction (gap) two type; synapse in spinal reflex found in **grey matter**

- **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

☝ **Type of neuron**

I. **Affecter, Afferent, Sensory neuron**
- Carry impulses from receptor to CNS /spinal cord and brain/
- **Cell body** is located in **dorsal root spinal ganglia**

II. **Effector , Efferent, Motor neuron**
- Carry impulses from the CNS /brain and spinal cord/ to the effectors organs (muscles and gland
- Cell body is found **grey matter of spinal cord.**

III. Relay (inter neuron)
- Found in central nerve system
- Connect sensory and motor neuron
- Transfer incoming neuron from sensory to motor neuron

☝ **The pathway of an impulse during nerve coordination**
- Sense organ → afferent neuron → central nervous system → efferent neurons → effector / muscles or a gland /.

Nerve impulse transmission

❖ **Nerves** are bundles of neuron fiber**. 3 different type of nerve**
- **Effectors nerves,** carry only effectors neurons
- **Affecter nerves**, carry only affecter neurons
- **Mixed nerves.** carry a mixture of effectors and affecter neurons

☝ **Nerve impulse**
- ❖ An electrical message that move from one part of the neuron to others
- ❖ Is an electrical events that is the result of charge difference across the membrane of axon
- ❖ If the neuron is resting or **polarized.** outside positive inside negative
- ❖ When impulse transmit, the positive charge comes inside and the negative charge comes out side. This condition is known as the **action potential.**
- ❖ A neuron during action potential is called **depolarization**
- ❖ **Action potential** is a wave of depolarization across a neuron**.**

☝ **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 organo phosphorus** compounds deactivate the enzymes on the second membrane and so prevent the breakdown of acetylcholine. The nerves fire continuously and 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

Central nervous systems; the brain and the spinal cord

1. The Brain

- Brain is enclosed in membranes and protected by the bones of **skull** 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,
  - 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** the bulk of the brain– the cell bodies of neurons and the synapses that connect them.
- **white matter** is Inside the brain -the axons that lead into and out of the brain

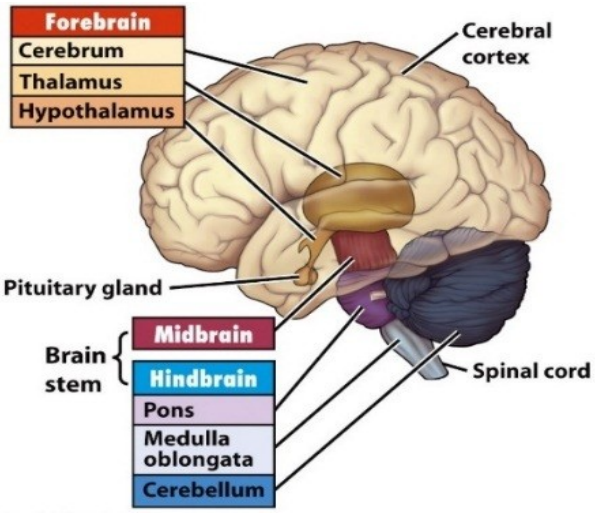
☝ **Parts of the brain**

a) **The fore brain** consists

- **The cerebral hemispheres**
  - involved in speech, intelligence, tho
  - dealing with coordination of sensory and motor function
- **Hypothalamus** regulation of temperatu thrust, sleep, emotion and reproductive h

b) **The mid brain** that deal with vision (the opti

c) **Hind brain** consists;



- **cerebellum** deal with balance and orientation
- **Medulla** regulate respiration, breathing, Circulation and salivation

2. The spinal cord

- Runs out from brain down body.
- It is encased and protected by the vertebrae making

☝ **The cross section of spinal cord**

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

☝ **Root of spinal cord**

- **Dorsal root** at the back of the spinal cord
  - Sensory impulse enter the spinal cord through dorsal root
  - Contain sensory (affector) neuron
- Ventral root at the front of the spinal cord
  - Motor impulse leave the cord to the effectors organ through Ventral root
  - Contain motor (effector) neuron

☝ **Function of spinal cord**

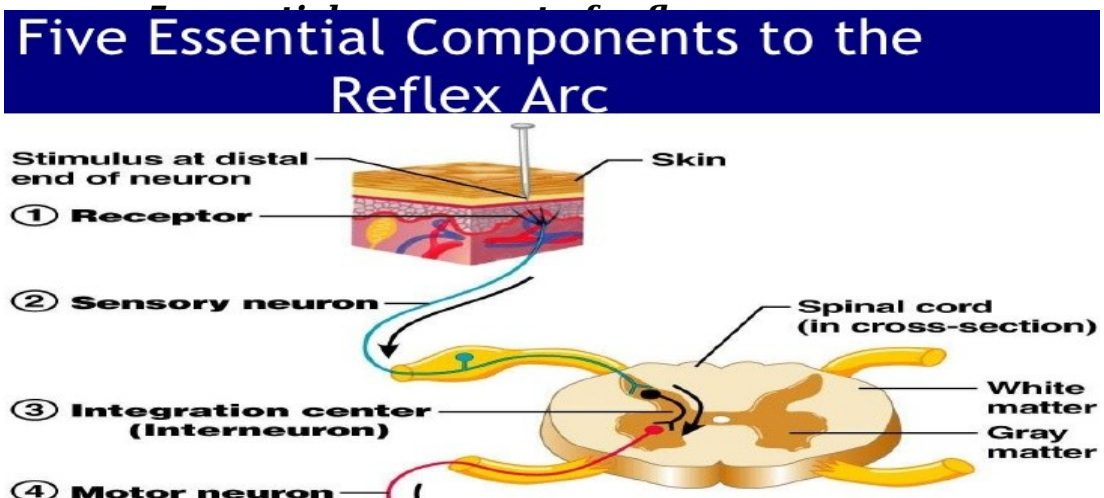
- It serves as a **center of reflex action**
- It serve as the pathway of motor impulse from the brain to various part of the body and also sensory impulse from various part of the body to brain

Reflexes (Reflex action)

- Is sudden ,automatic, and uncontrolled response part of the body or the whole body to external stimuli
- Important for the body by providing 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** → **Effectors (muscle and gland)** → response



There are two type of reflex action

I. Simple reflex action
II. Conditioned reflex action

1) Simple reflex action

- Avery rapid, involuntary, Automatic response to stimuli
- Example of simple reflex action
  - Knee-jerk reflex
  - Withdrawal from heat
  - Blinking of the eye sneezing , coughing

2) Conditioned reflex

- It is not inborn
- It is dependent on past experience and training
- Example Pavlov's experiment

A. Before conditioning

- Food(unconditioned stimulus) $\xrightarrow{\text{RESPONE}}$ salivation =unconditioned response
- Hand bell (neutral stimulus) $\xrightarrow{\text{RESPONSE}}$ no salivation (no response)

B. During conditioning

- Hand bell +food $\xrightarrow{\text{RESPONSE}}$ 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	➢ It is under the control of the will

will

- E.g. **blinking, salivation, coughing, peristalsis, secretion, heart beat**
- E.g. **Writing, Dancing, Eating, Driving, singing, Walking**

Drug abuse

- **A drug** is a substance which alters the way in which mind, or body, or both, works. .
- In Ethiopia caffeine, nicotine, khat and alcohol are the legal recreational drugs.
- **Drug abuse** is use a substance to the point of excess and/or 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,
  - often experiencing combinations of aches and pains,
  - Shaking, sweating, headaches,
  - Cravings for the drug
  - Even fevers as the body reacts –
- Alcohol, khat and tobacco are legal drugs in Ethiopia but cannabis is illegal.

1. **Smoking** the addictive drug in cigarette smoke is **nicotine**, physically addictive.
   - Smoking increases the risk of developing the following diseases:

☝ **Coronary Heart Disease**

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

☝ **Strokes**

- Damage or blocked of the blood vessels taking blood to the brain
- This may lead to paralysis, memory loss and even death.

☝ **Lung Disease**

- **Tar and other chemicals** in tobacco smoke damage the tissues of the lungs a
- This lead the risk of developing chronic obstructive pulmonary disease **(COPD) and lung cancer.**

☝ **Cancers (lip, mouth, throat, pancreas, bladder and kidney)**

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

2. **Alcohol**
   - Alcoholics people who are addicted to alcohol may develop **cirrhosis of the liver** disease destroys liver tissue. They can also get liver cancer
   - Drinking alcohol have social and economic impact on people
3. **Khat;** the drug **cathinone** from the khat leaves is absorbed into the bloodstream and affect the body
4. **Cannabis (marijuana)**
   - It is a dangerous hallucinogen drug that contain a chemical called cannabinoids,.
   - **Delta-9 tetrahydrocannabinoid** (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.
7. **Heroin**
   - Heroin is medically as very **good painkillers and as recreational drugs,**
   - Increase the risk of liver diseases such as hepatitis, heart and brain damage.

3.2 Sense organs

- Sense organ contain sensory receptor that detect a particular stimulus,

In dim light	***In bright light,***
The radial muscles contract	*The circular muscles of the iris contract*
The circular muscles relax	*The radial muscles relax,*
The pupil is pulled open wide (it dilates).	*Pupil very small (it constricts*

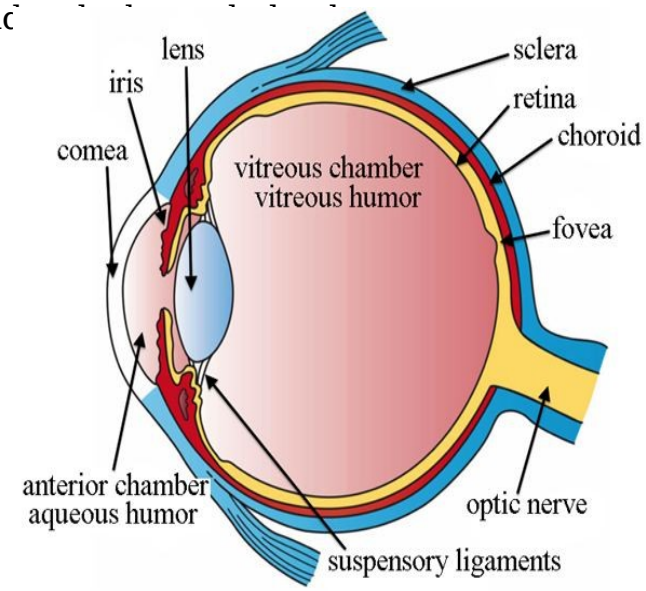
- A sensory organ is an organ that contains a large number of sensory receptor cells and the human eye is a good example

- 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 and brain (chemo receptors responding to pH and carbon dioxide levels	Chemical

THE HUMAN EYE

- **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 glan
- **Parts of the eye**



A. **The sclera:** the tough, opaque external covering of the eye.
   Important to protect and maintain the shape of eye ball , white part of eye

B. **Cornea** transparent front part of sclera , important to bend light ray toward retina

1. **Choroid** the middle pigmented layer of the eye. rich in blood vessel that supply nutrient and oxygen to the cell of retina
2. **Pupil;** is a hole in the center of the iris, through which light enter the eye
3. **Iris** is the colored part of the eye

-It contain two set of muscle called **circular** and **radial**

-Responsible for controlling the amount of light entering the eye the retina

3. **The lens**, a flexible disc that helps focus light on the retina
   - ❖ The lens is held in place by suspensory ligaments and the Ciliary muscles.
4. **Suspensory ligaments** elastic-like structures that suspend the lens and pull lens into shape for focusing distant objects onto the retina
5. **Ciliary muscles** eye muscles that automatically contract and change the shape of the lens by changing the tension of suspensory ligaments

Rods	**Cones**
❖ Respond to relatively low 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**	❖ Responsible for bright light color ❖ They give a very clear, defined image ❖ Responsible for color vision ❖ More concentrated in and around fovea ❖ Occur greater on retina ❖ **Color blindness** is the **genetic disorder inability** of the eye **to distinguish colors** like red, blue and green

Retina; the inner layer of the eye

- It contains special light-sensitive **photoreceptors** called roads and cones

I. **Fovea (yellow spot)**
   - The most sensitive part of retina
   - It contain cones, Most light ray are focused on it

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

6. **Aqueous humor**; is a watery fluid that fill the front chamber of the eye,
   - maintain the shape of eye ball
7. **Vitreous humor; is** jelly like (semi solid) substance that fill the area behind retina. it also maintain the shape of eye ball
8. **Optic nerve;** the bindle of nerve fibers that transport nerve impulse from retina to brain

☝ **Accommodation; the ability** of the eye focusing near and distance object

Focusing on a distant object
- Ciliary muscles relax
- Suspensory ligaments pulled tight
- lens 'flat' and less convex (flatter)

Focusing on a nearby object
- Ciliary muscles contract
- Suspensory ligaments slacked off
- Lens more rounded and more convex (rounded)

Common eye defects

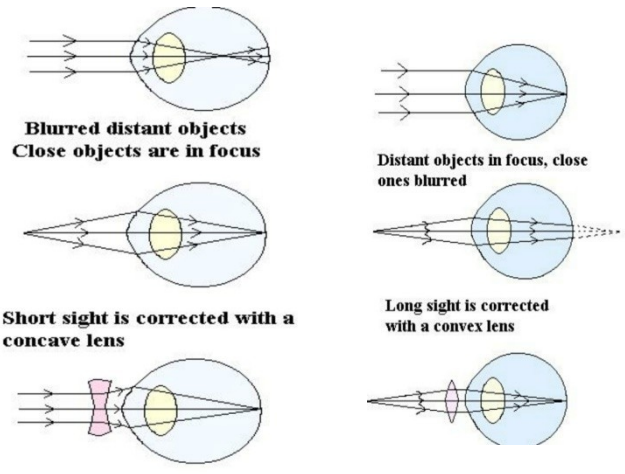
☝ **Short sight(myopia)**
- The condition where the eye can only sea near object
- Cannot sea objet from long distance
- Image of far objet formed in front of retina

Caused by
- **Longer eye** ball then normal
- Lens is '**too strong' and curved**

While Ciliary muscle relaxed

Corrected by

Wearing **diverging (concave)** lens



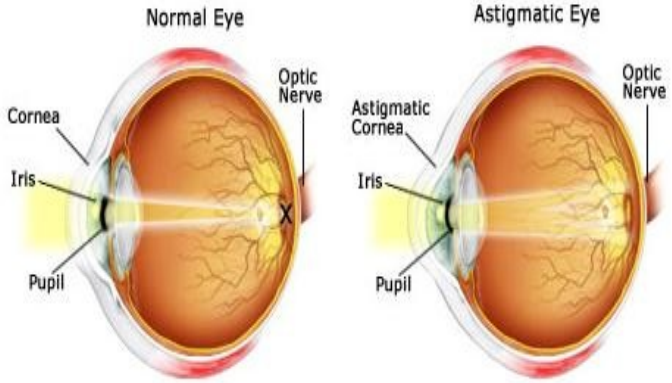
☝ **Long sight (hypermetropia**)
- A condition where the eye can only see far object
- Nearby object cannot see clearl
- Image of near object focused be

Caused by

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

Corrected by; wearing **converging (convex)** lens **Short sight**

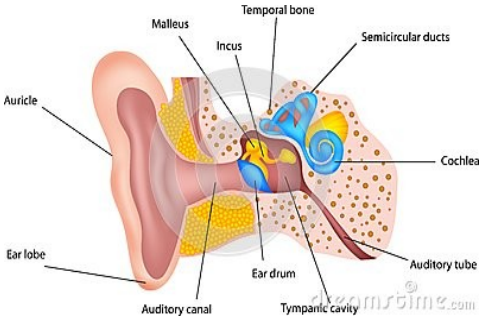
Long sight



- **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.
  - **Corrected by**; irregular lens

THE EAR

- The human ear are responsible for
  - Hearing
  - Balance and position



- The ear divided into three regions

A. Outer(external ear)

Pinna; direct sound wave into ear canal

- Helps to know the direction of sound

Ear canal

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

Ear drum (tympanum)

- A tiny and delicate membrane

B. The middle ear (air filled cavity)

- It contain three tiny bones (**ossicles**)
  - ✓ **Hummer /malleus/**attach to ear drum
  - ✓ **Anvil /incus/**
  - ✓ **Stirrup /Stapes/** attach to oval window
- **Eustachian tube;** helps to equalize air pressure between outer and middle ear

C. The inner ear / fluid filled cavity/ consists;

- **Cochlea** a coiled tube
  - ✓ Contain nerve ending of auditory nerve
  - ✓ It is sensitive to sound vibration
- **Semicircular canal;** consists of cell that are sensitive to the motion of body
- **Utricullus and sacculus; are** concerned with the balance and posture

- **The path way of vibration in the ear**

Pinna → ear canal → **eardrum** → Hummer/malleus → Anvil /incus/ Stirrup/stapes → 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
- Loud noise Infection

TASTE AND SMELL

- **Tongue**
  - Taste are caused by chemical stimuli
  - **Taste bud** are sensory receptor of taste
    - Located on the upper surface of the tongue
    - Sensitive to dissolved substance on the tongue
  - There are five different types of taste buds spread evenly across the tongue. these 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.
- **The nose**
  - Smell is caused by chemical stimuli
  - Smell receptor are called **olfactory cells**
    - Olfactory cells located in the roof of nasal cavity
    - Similar to sense of taste however, nose **detects dissolved chemical at distance**

THE SKIN AS A SENSE ORGAN

- Human skin is sensitive to five types of stimuli **touch, temperature, pain and pressure**. Due to the following receptors
  I. **Meissners corpuscles;** Touch
  II. **Pacinin corpuscles;** pressure
  III. **Thermo receptors;** Temperature /Coldness and hotness/
  IV. **Nocireceptors;** pain
- **Importance of the skin**
  - 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.**
  - **Hypodermis/Subcutaneous layer/;** the lower layer,
    - Contains fatty tissue which helps to insulate the body against heat loss.
  - **Dermis;** the middle layer

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

❖ **Epidermis;** the upper layer /made up of dead cells/.
- Stop water loss and also protect against the entry of pathogens.
- particularly involved in the homeostatic mechanisms of the skin

3.3 THE ENDOCRINE GLAND

- Glands are structures that produce hormone and other useful substance. There are two types of glands
- **EXOCRINE GLAND (duct gland)**
  - ❖ Release its secretion in to its ducts
  - ❖ Some example of exocrine gland
    - Salivary gland
    - Sweat gland
    - Mammary gland
    - Pancreatic gland
    - Intestinal gland

- **ENDOCRINE GLAND (ductless gland**)
  - ❖ Gland without duct
  - ❖ Transport there secretion 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**
  - ❖ The cell contain receptor cells specific to the hormone to find target cell
  - ❖ Hormone have a long term effect on the body such as growth , development, metabolism, reproduction
  - ❖ Some examples of endocrine gland;

1. PITUTARY GLAND
- ❖ **Found in the brain**
- ❖ Control the activity of other endocrine glands. Thus ,it is called **master gland** or an **endocrine orchestra**
- ❖ 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 secret at the end of pregnancy to initiate uterus contraction to cause birth

2. THYROID GLAND

- Found in neck region in front of wide pipe
- Secret iodine contain hormone called **thyroxin**
- It involve in regulation of
  - Rate of metabolism
  - Stimulate the conception of oxygen by most cell
  - Development of brain in children

Too much 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

Low level of thyroxin

- **M**etabolic 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. This condition is known as **goiter**
- Goiter prevented by including more iodine in our diet

3. PARTHYROID GLAND

- Four tiny structure found at the back of thyroid gland
- Produce a hormone called **parathyroid hormone (Paratho hormone)**
- Parathyroid hormone control the amount of calcium ion in body fluids
- 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. PANCREASE

- Pancreases is both endocrine and exocrine gland
- Contain endocrine gland called **'islets of langerhans'**
- Secretes two hormone known as **insulin** and **glucagon**
- Control blood glucose level in the body
- Insulin and glucagon are **antagonistic hormones** because they have opposite effect on glucose level

INSULINE	GLUCAGON
Secretes when blood glucose level higher than normal	Secretes when blood glucose level higher than normal
Decrease blood glucose level by;	**Increase blood glucose level by;**
Glucose is removed by cellular respiration	Stimulate the conversion of glycogen into glucose **glycogen → glucose**
Increase the take up of glucose by cells	Stimulate the formation of glucose from amino acid and fat
glucose is converted into glycogen in liver and muscle cell	The deficiency of insulin and glucagon cause the disease called **diabetes**
glucose → glycogen	

- **Type 1 diabetes :** appeared in children, It is inherited ,cannot be avoid
- **Type 2 diabetes:** appeared in person life, can be linked , being obese

5. ADRENAL GLAND

- Found on the top of kidney
- Adrenal gland have two separate and independent parts
  - Adrenal cortex (outer layer)
  - Adrenal medulla (Inner layer)

Adrenal medulla (fight and flight hormone)	Adrenal cortex
Produce a hormone called **adrenalin**	Secret complex steroid hormone called **corticoids**
Secret under stress, emergency, excited, freighted situation	Control certain phase carbohydrate, fat and protein metabolism
Important for preparing the body for action	Another hormone release by

- The main change produce by adrenalin
  - Increase heart rate
  - Increase breathing rate
  - Pupil dilates
  - Body hair stand

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

- **GONADS (sex gland)**

A. Testes

- **P**roduce male sex hormone **testosterone**
- Control male secondary sexual characteristics such as:
  - The whole body growth spurt, Tests began to produce sperm
  - Pubic, body and facial hair began to produce sperm
  - Voice deepens , Body become ,more muscular

B. Ovaries

- Produce female sex hormone called **progesterone** and **estrogen**

Estrogen

Cause the development of female secondary sexual characteristics such as;

- The whole body under goes growth spurt
- Brest develop
- Widening of hip
- Ovaries began to produce egg
- Menstruation begins
- Voice become thinner

Progesterone

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

Menstrual cycle

- **Menstruation**; monthly discharge of blood and cell shed from endometrium
  - **Menstrual cycle** is a sequence of events which takes place approximately every four weeks
  - 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

- **Hormones involve in menstrual cycle**

I. Produce by pituitary gland

Follicular stimulating hormone FSH)

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

Latinizing hormone (LH)

- Stimulate the release of egg from ovary
- Stimulate the ovary to produce progesterone

II. Produce by ovary

Estrogen

- *Responsible for the development of feminine traits*

Progesterone

- *Prepare the uterus for implantation of fertilized egg*

3.5 HOMEOSTASIS

- **Homeostasis**: is the ability of the body maintains a Constant internal environment.
  - Come from two Greek words.
    Homoios; like
    Stasis; states
  - Keeping internal environment the same state.
  - The body ability to maintain a constant internal environment
  - The ability of an organism maintaining a constant internal environment both in tissue fluids and cells.
  - Homeostasis makes living organism in **steady state.**
  - A **steady state** is the rate of input substance equals the rate of output substance.

3.5.1 Controlling temperature

- **Temperature** is a way of measuring hotness and coldness of something.
- **Living organism continually gained heat by;**
  - **Conduction** the transfer of heat through direct contact
  - **Conviction** the transfer of heat through the current of air and water
  - **Radiation** the diffusion of heat from warmer to colder through the air
  - **Cellular respiration**
- **Living organism continually losing heat by**;
  - Conduction

- ❖ Conviction
- ❖ Radiation
- ❖ Evaporation

With regard to temperature regulation organism can be divided into two major groups.

1. Poikiltherms 2.Homoiotherms

1. Poikilotherms

- ❖ Body temperature governed by external temperature.
- ❖ Body temperature vary over a wide range
- ❖ E.g.; Invertebrates , Fish, amphibians and reptiles

Poikilotherms Organism	Environmental temperature	Body Temp.
Fish	25^0C	25^0C
	30^0C	30^0C
	40^0C	40^0C

2. Homoiotherms

- ❖ Constant internal body temperature
- ❖ Independent of environmental temperature
- ❖ E.g.; Birds and mammals

Homoiotherms organism	Environmental temperature	Body Temp.
Human	25^0C	3 7^0C
	30^0C	3 7^0C
	40^0C	3 7^0C

☝ **Temperature controls in Poikilotherms**

When hot

- ❖ Move into shade
- ❖ Move into water

when cold

- ❖ press their body to warm temperature
- ❖ Bask in the sun
- ❖ Erect special sails to absorb more heat from the sun

Temperature controls in Homoiotherms

1. Physiological method

i. **Heat losing mechanism** in response to **hot condition** in order to **cool** the body

A. Sweating carries

- ❖ As sweat evaporates from the skin surface it has a cooling effect because the evaporating liquid carries away body heat.

B. Vasodilatations

- ❖ Is the widening(dilates) of blood vessels
- ❖ More blood flows through the capillaries
- ❖ More heat is lost through radiation from the surface

C. Panting and licking

- ❖ Man mammals have thick and furry coat so sweat cannot evaporate from the skin surface
- ❖ Some animals, such as dog and cats may lick themselves with saliva to coal the body
- ❖ They also pant, which allows more heat to evaporate from the moist surface.

ii. Heat gain mechanism operates in response to **cold condition** in order **to worm** the body

A. Vasoconstriction

- ❖ Narrowing (constricts) of blood vessels
- ❖ Reduce the flow of blood through capillaries
- ❖ Reduce heat lost through the surface of skin

B. Piloerection→pulling the hair upright

- ❖ **When body temperature fails (drops)**
  - ➢ Hair erector muscle contract and pulling the hair upright, trapping an insulating layer of air to conserve heat.
- ❖ **When body temperature rises**
  - ➢ Hair lie flat, hair erector muscle relaxes and reduce an insulating layer which makes easier to loss heat by conviction.

C. Shivering and metabolic response

- ❖ **When body temperature fails (drops ,cools)**
  - ➢ Metabolic rate speeds up
  - ➢ The muscle starts shiver and contract rapidly
  - ➢ The rate of respiration increase to generate more heat
- ❖ **When body temperature rises(warms up)**
  - ➢ Shivering stops
  - ➢ Metabolic rate drops and less heat produce.

D. Fat layer under skin →subcutaneous fat

- ❖ Serve as an insulator and reduce heat loss from the body in cold climates.
- ❖ Animal that lives in cold climate like polar bear and seal have thick layer of fat which aid in heat conservation.

2. Behavioral method of temperature regulation

- ❖ Clothing
- ❖ Bathing
- ❖ Seeking shade and shelter
- ❖ Taking high calorie food
- ❖ **Hibernation;** animal response to cold environment undergo period of dormancy (deep sleep)

- **Aestivation ;** Animals response to hot environments undergo a period of dormancy (deep sleep)

3. Morphological method of temperature regulation

- Surface to volume ratio is the amount of surface area to per unit volume
- As organism get larger both its surface area and volume increase but the volume increase faster than surface area.
- Smaller organism tending to have a greater surface area to volume ratio than larger animals
- Smaller organism tend to loss heat faster than larger organism

To sum up

- **Smaller organism**
  - Larger surface area to volume ratio
  - Loss heat faster
  - Adapted to live hot condition
- **Larger organism**
  - Smaller surface area to volume ratio
  - Do not loss heat faster
  - Adapted to live cold condition\

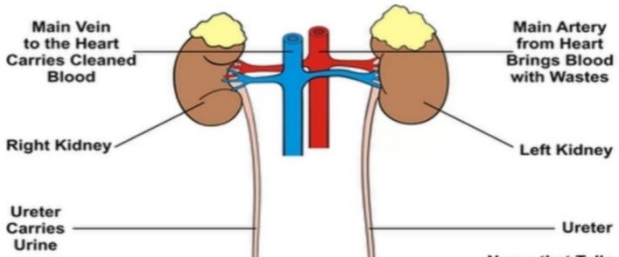
HYPOTHERMIA

- Occurs when your body losses heat faster than it can produce heat
- Causing a dangerous low body temperature
- Normal human body temperature is **37^0c or 98.6^0F**
- **Hypothermia occurs** as your body temperature **passes below35^0c or 95^0F**

Controlling core body temperature

- Human being have internal control mechanism (homeostasis)
- Loss excess heat if core body temperature rises
- Conserve heat when core temperature starts to fall.
- **Thermoregulatory center** of the brain (hypothalamus) control the core body temperature
- The control of core body temperature is an example of **negative feedback loop**.

- **As body temperature rises;** hea**t lost** from the body using:
  - Dilation of blood vessels ,blood flow through the capillaries increase and more heat is lost
  - Lot of sweat produced and hair lie flat
- **As the core body temperature fails;** heat gain to the body
  - Contraction of blood vessels , decrease blood flow to the capillaries, less heat is lost



- No sweat is produce
- Hairs pulled erect to trap insulating the air

3.5.2 Homeostasis in the kidney

- Kidney, lung and skin are the main excretory organ of the body
- Human kidney has **important in two aspect of homeostasis**:

i**. Excretion** ii. **Osmoregulation**

1. Excretion.

- The removal of metabolic waste from the body
- Kidney removes nitrogenous waste such as urea.
- Urea is produced in the liver.
- Excess amino acid
  - Amino group; convert to ammonia
  - Carboxylic acid: converts to carbohydrate
  - Urea→ammonia + carbon dioxide
  - Urea filtered out of blood by kidney and removed as urine

2. Osmoregulation. Control of water and ion balance in the body

The kidney

- Blood **filtration and purification organ**
- Each kidney connected to a tube called **ureter** , carries urine to the bladder
- **Bladder;** urine is stored until it is ready to be passed away from the body
- **Sphincter**-a ring of muscle that control the opening of bladder
- **Urethra**-A duct through which urine is discharged
- **Renal arteries;** carries oxygenated blood to the kidney
- **Renal vein;** carries deoxygenated blood away from the kidney

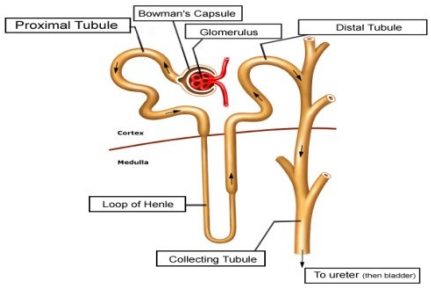
- **Nephrones**
  - Microscopic structure of the kidney
  - Functional unit of the kidney where blood is filtered and urine is produced
  - Consists of a cluster capillaries known as **glomerulus**
- **Section of nephrones**
  1. **Bowman's capsules** site of ultra-filtration
     - **Ultra filtration** the removal of excess water and other substance from the blood into bowman's capsules.
     - **Glomerulus—**the knot of blood vessels in bowman capsules
       - **Afferent arterioles; a**rterioles that takes blood into the glomerulus
       - **Efferent arterioles;** arterioles that leading blood away from the kidney

- **Glomerular filtrate—**the liquid resulting from filtration in the bowman capsules

2. First coiled (convoluted) tubules –Reabsorption of useful substance

3. Loop of Henley- urine is concentrated and more water is conserved.

4. **Second convoluted tubules**—the main water balanc



The role of ADH in second convoluted tube

- **If the water contents of the blood is too low-**
  - More ADH is released into the blood
  - Kidney tubules reabsorb more water
  - Little dark colored concentrated urine is produced

Fig: nephrons

- **If the water content in the blood is too high**
  - Less ADH is released into the blood
  - Kidney tubules reabsorbs less water
  - Much pale colored urine is produced

3.5.3 Liver and homeostasis

- **T**he liver is the **body's chemical factory**
- It performs many different chemical Processes.
- The largest organ in the body and it can regenerates itself if it gets damaged
- Liver has a special blood supply
  - **Hepatic artery**—carries oxygenated blood to liver
  - **Hepatic vein**-remove deoxygenated blood from liver
  - **Hepatic portal vein-**comes from liver directly from gut
    - Brings the product of digestion to the liver

- **Liver plays the following role:**
  - Regulation of blood glucose level- because glucose is used;
    - ✓ **Source of energy**
    - ✓ **Affect blood osmotic potential**
  - Protein metabolism; the process of removing amino group from amino acid is called **deamination**
  - Control toxins **-**change harmful substance to harmless **Detoxification**
  - Temperature control
  - Control fat and cholesterol in the blood
  - Production of plasma protein