Date:

Biology Introduction

- Biology is the study of living organisms and their interactions with the environment.

- Living things:
  - Respire
  - Have a life cycle
  - Excrete
  - Move
  - Consume Nutrition
  - Adapt to environment
  - Sensitivity
  - Have cells
  - Grow
  - Reproduce

- Non-living things could do all of the above, except for grow and reproduce.

Date: - CELLS

- Cells are the smallest units of life, but are capable of surviving in mediums free of life.

- There are 2 main types of cells:
  - Prokaryotic (Before Nucleus): In unicellular organisms. They have no membrane-bound organelles.
  - Eukaryotic (True Nucleus): In multicellular bodies. They have complex organelles and are located in plants, animals

- Functions of a cell include:
  - Containing DNA
  - Sensitivity
  - Nutrition
  - Making enzymes/proteins

- A cell contains organelles, mini-organs that carry out these functions.

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- How a cell compares to a factory:
  - Nucleus - Head Office
  - DNA - Manager
  - Proteins - Product
  - Smooth Endoplasmic Reticulum + Ribosomes - Machinery
  - Cytoplasm - Free space
  - Vacuole - Storage Room
  - Cell Membrane - Guards
  - Mitochondria - Power House

- The cell membrane is a sheet-like protective surface. It is selectively permeable, and lets only some particles pass through. It is made of a phospho-lipid bilayer.

- Ribosomes are small globular structures that produce proteins. Ribosomes are made in the Nucleolus. There are two types of Ribosomes - free and membrane-bound ribosomes. Free ribosomes

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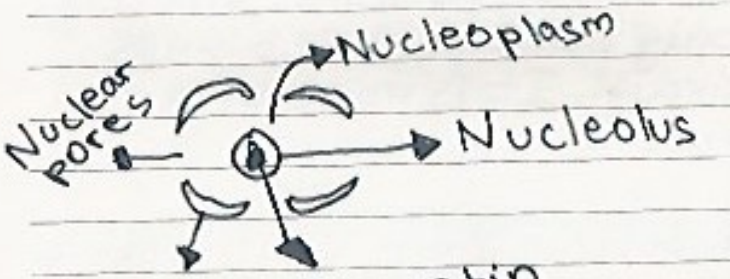
roam around freely in the cytoplasm. They synthesize protens for the use of the cell, while the other type, membrane-bound (attached to Rough Endoplasmic Reticulum) synthesize them for external use.

- The Nucleus is the Head Office of the cell. It contains the DNA. The Nucleus have 5 components:



- The Nucleolus makes Ribosomes. The Chromatin contains DNA, and it condenses to form chromosomes.

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- The Cytoplasm is the jelly-like substance inside a cell that counts as free space.

- The Rough Endoplasmic Reticulum (RER) is right outside the Nucleus. It is a flattened structure, and is joint to the Nuclear Envelope. It synthesizes and modifies proteins (polypeptides) [illegible]. It has ribosomes attached to it, giving it a "rough" appearance.

- The Smooth Endoplasmic Reticulum (SER) synthesizes lipids and removes harmful substances. This process is known as detoxification. The SER also creates vesicles.

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- The Golgi Apparatus (also called Golgi Body) is a flattened disk-like structure. It has the same membrane as the Cell Membrane. It processes and packages proteins in vesicles. Vesicles are thus modified within. Then, they (the vesicles) merge with the Cell Membrane. The flattened shape of the Golgi Body gives a higher surface Area: Volume Ratio.

- Mitochondria is the "power house" of the cell. They carry out cellular Respiration. They have their own DNA. They create ATP (Adenine Tri Phosphate), which helps create and send energy where ATP is a currency. They have 2 membranes, so enzymes are attached to them.

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- The chloroplast is the other organelle with a double membrane. It contains a pigment called Chlorophyll, which gives the chloroplast its green colour and helps in photosynthesis (which is why Chloroplasts are only present in plants and algae).

- Vacuoles are large fluid-filled spaces enclosed by membranes. Plants have one large, central vacuole, while animals have several temporary and small vacuoles. Their membranes are called tonoplasts. It is permeable to water. Vacuoles contain salt and glucose.

- Centrioles are small, round structures that help in Cell Division. They are only present in animal cells. They

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appear in pairs. In any cell, there is only one pair of centrioles. They have a copy of the DNA and are proten in nature.

- The Cell Wall is an external layer only present in plants It is made up of cellulose. It has a rigid structure and is completely permeable. It provides support and prevents bursting. It can withstand water pressure.

- Lysosomes are Digestive Plants for proteins, fats and carbs. They transport undigested material to the cell membrane for its removal. The cell can break down if the Lysosome explodes.

- Differences between plant and animal cells:

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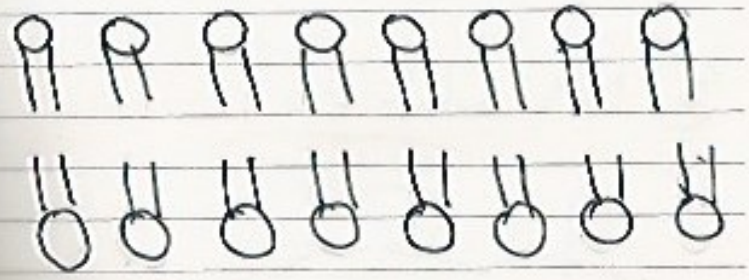
Plant Cell	Animal Cell
Rectangular	oval-like
Cell Wall	No Cell Wall
Chloroplasts	No chloroplasts
No centrioles	Centrioles
One, permanent large vacuole	Several, temporary, small vacuoles
Cilia not present mostly	Cilia present
No Lysosomes	Lysosomes

Organelles figures:



1. CELL MEMBRANE (Phospho-Lipid Bilayer)

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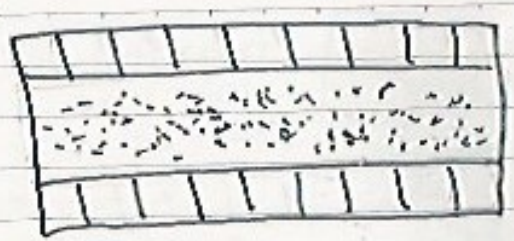
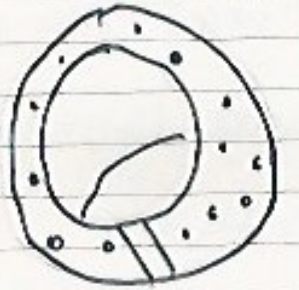


② CELL WALL



③ NUCLEUS

④ ENDOPLASMIC RETICULUM

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⑤ RIBOSOMES

⑥ MITOCHONDRIA

⑦ GOLGI APPARATUS

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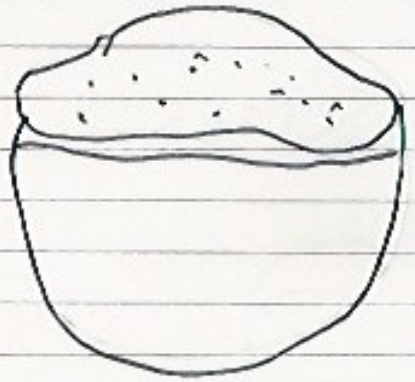

⑧ LYSOSOMES

⑨ CHLOROPLASTS

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- Some cells are specialized. They are modified and have particular structures and functions. They are formed through a process called "Cell Differentiation".

- Classic examples of specialized cells are Red Blood Cells (RBCs). They transport oxygen throughout the body and remove Carbon Dioxide. It needs storage, which is why they have no nucleus. It needs to store haemoglobin (a metalloprotein). They are created in the bone marrow. At the time of creation, they have a nucleus, but they remove it for increased storage. They have a biconcave shape to increase the surface Area to volume Ratio.

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- Stem cells are cells that have not yet differentiated. They are raw cells, and can order for the growth of the Liver, Heart, Kidney etc. Although the Heart, Liver etc. are organs, stem cells can order for their growth because:

① — CELLS
↓
② — TISSUES
↓
③ — ORGANS
↓
④ — ORGAN SYSTEMS
↓
⑤ — ORGANISMS

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- Histology is the study of tissues. There are 4 types of tissues:
  ① Ephithelial - Cover surfaces
  ② Connective - Support, Transport, Storage
  ③ Muscles - Contract
  ④ Neural - Carry Signals

- Antagonistic muscles are pairs of muscles working in opposite directions.

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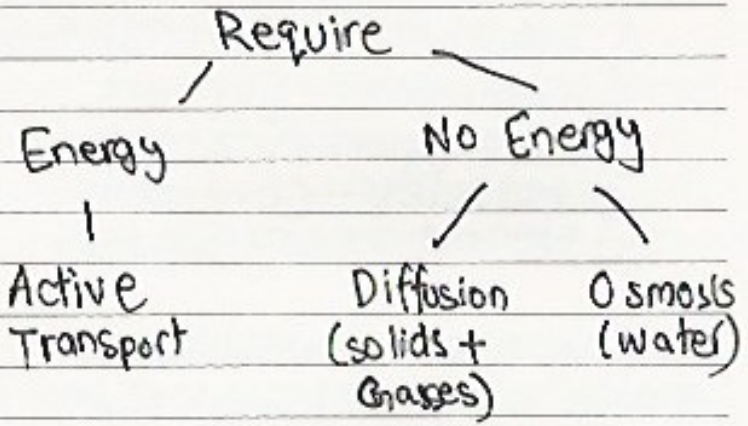
TRANSPORT

- There are 2 types of transport.



- Diffusion is the movement of particles from an area of higher concentration to lower concentration. Active transport is the opposite, but it requires energy.

- Osmosis is the movement of water particles from an area of higher water potential to lower water potential across a partially permeable membrane.

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- There are 3 types of solutions:
  - Hypotonic: Solvent > Solute
  - Isotonic: Solvent = Solute
  - Hypertonic: Solvent < Solute

- Brownean motion is the random type of motion of gas particles.

- Temperature affects particle movement. More temperature causes more kinetic energy, resulting in so. Mass affects particle movement. More mass causes more inertia. So a smaller mass allows for more speed of the particles. This goes for all types of transport.

- In Osmosis, equilibrium is equal concentration on both sides of a membrane. Even then, the particles keep moving, but the overall rate of diffusion does not change much

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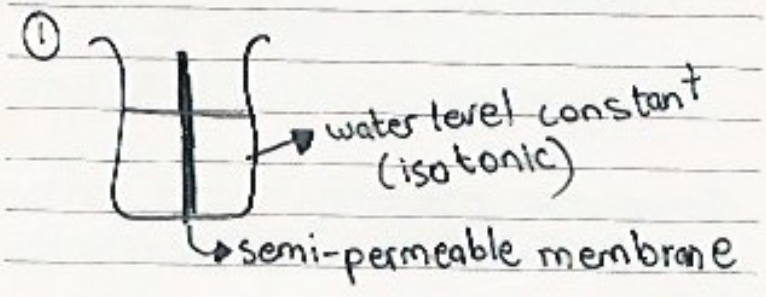
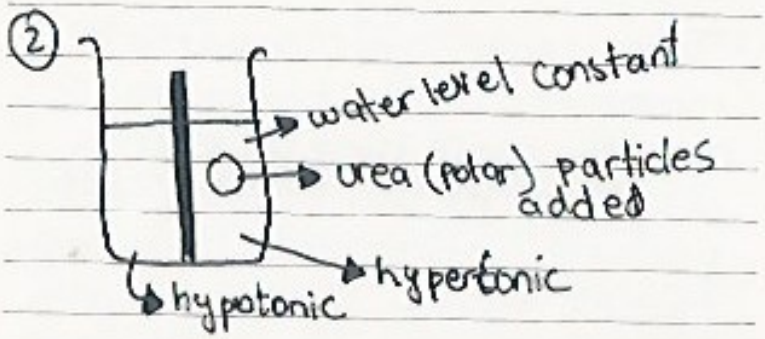
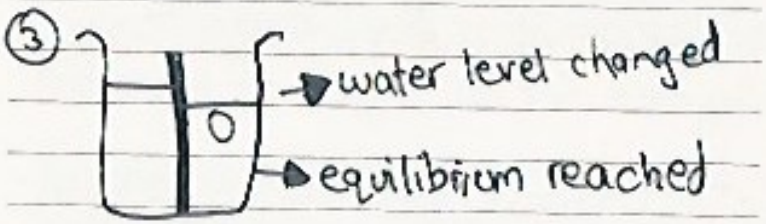
• How Osmosis works:







• Water molecules are polar too. However, they are so small that they can diffuse across a membrane.

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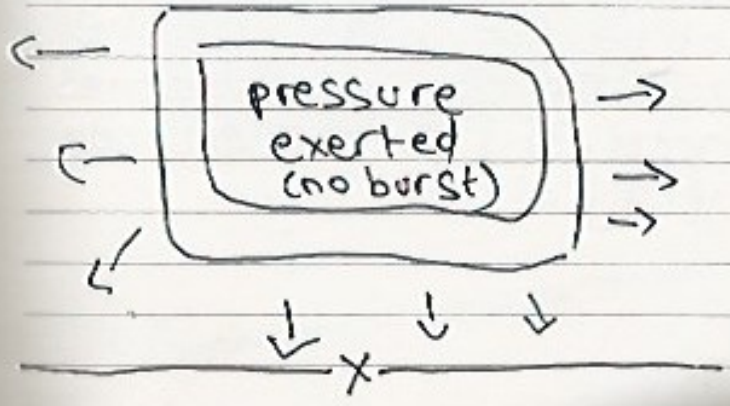
• When a cell is placed in water, the cell will give out water, because the concentration outside the cell is greater. Hence, the cell shrinks. This process is called plasmolysis. In hypotonic solutions, the cell will take in water, causing it to burst. This process is called Lysis. Plant cells plasmolyse, but do not burst. This is because of its cell wall. The pressure on the Cell Wall (given by the expanding cell Membrane) is called turgor pressure. The phenomenon is called turgidity. The plant becomes turgid.



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- Cells are deliberately very small. If they were bigger, nutrients would not enter the cell fast enough, and heat and waste would not be released so quickly. A smaller cell size increases its "Surface Area : Volume Ratio"

- Here, the Surface Area has to do with the amount of nutrients/resources that can enter the cell at one time.

- The volume has to do with the amount of nutrients needed to run the cell.

- However, the SA:V Ratio should not be <u>too</u> high, else the excretion of waste becomes harder. If this happens, cells typically divide.

K2 (Karakoram)

K2 is the second highest mountain in the world, located in the Karakoram section of the Himalayas between Pakistan and China. K2, also known as Mount Godwin-Austen or Chhogori, stands tall at 8,611 metres (28,251 ft) above sea level, second to only Mount Everest. The heights of the peaks complement the region's grandiose landscape.

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HUTCHISON PORTS PAKISTAN

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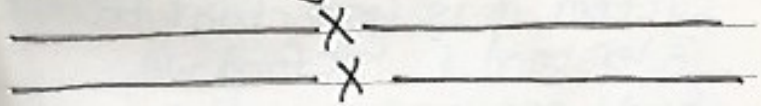
Size of Side	Surface Area	Volume	Ratio
1	6	1	6 : 1
2	24	8	3 : 1
3	54	27	2 : 1
4	96	64	1.5 : 1
5	150	125	1.2 : 1
6	216	216	1 : 1
7	294	343	0.9 : 1

- Here, the shape of cells is taken as cubes for ease.

- Size 1 is ideal, while 6 is the maximum, after which a cell starts showing inefficiency



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ORGAN SYSTEMS

- A group of organs working together is called an organ system. There are 11 organ systems in the human body:
  - Digestive
  - Excretory
  - Circulatory
  - Respiratory
  - Nervous
  - Immune
  - Reproductive
  - Endocrine
  - Etc.

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- Before we get to digestive system, it is important to understand what food we should consume, all the nutrients etc. Nutrients are substances that provide you energy. In a balanced diet, one needs: BALANCE, VARIETY and MODERATION.

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- Categories of food:
  - Macronutrients (high quantities)
    - Carbohydrates
    - Proteins
    - Fibers
    - Water
    - Fats
  - Micro nutrients (small quantities)
    - vitamins
    - Minerals

- Water is a Universal Solvent. It carries Nutrients and Waste, Regulates body Temperature, Dissolves Nutrients and Lubricates joints. Up to 70% of the human body is water.

- Fiber is not really a nutrient. It just helps in digestion (which is why faeces is often the quick result of consuming an apple). Fiber reduces the chance of obesity, and is not broken down during digestion.

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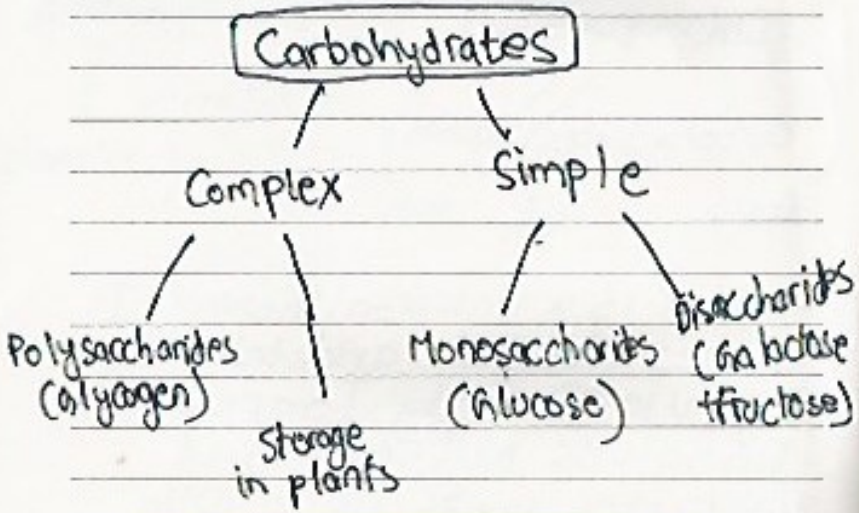
- Carbohydrates are the body's main source of energy. There are different types of Carbs:



- Polysaccharides have vitamins, minerals and fiber.

- Proteins, or Polypeptides, provide energy on the last resort. They help repair body tissues. They are made up of chemical compounds called amino acids. There are 20 types of amino acids (building blocks of proteins). 11 of these can be

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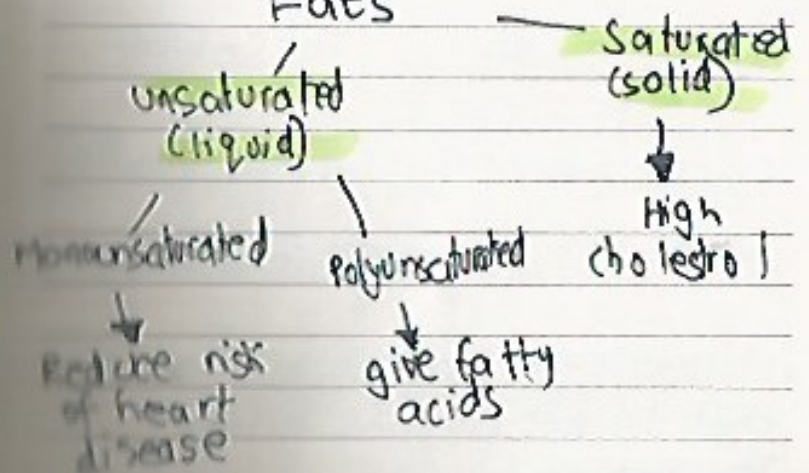
produced by the human body 9 of these come from the food we consume. Complete proteins provide these 9 essential nutrients.

- Fats/Lipids have the most amount of storage. They are hydrocarbons. Its functions are:
  - Providing substances
  - Providing energy
  - Enhancing taste/texture of food.



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- Cholestrol is a fat-like substance part of every cell of the body. It helps the body make necessary cells and aids in digestion. It is found in animal meat and created in the human body.

- Vitamins are nutrients that do not provide energy. They help regulate chemical processes. Two types:

Water Soluble
C, B
(large quantities)

Fat Soluble
A, D, E, K
(small quantities)

~~Minerals are inorganic nutrients~~

- Minerals are inorganic micronutrients that do not provide energy.

~~The human~~

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NUTRIENT CHART

Nutrient	Food Sources	Deficiency	Function 1	Function 2
Carbs	Rice, Biscuits	Ketosis	Respiration	Fuel
Water	water, water in food	Dehydration	Lubricates joints	Regulates body temperature
Fiber	Oatmeal, fruits	Constipation	Helps in digestion	Reduces risk of heart disease
Proteins	Fish, Eggs	Disorderly blood clotting	Helps repair tissues	Last resort of energy
Fats	Butter, Nuts	Depression	Provide energy	Carry fat soluble vitamins
Vitamins	Fruits, vegetables	★★ Depends ★★	Help carry out body processes	★★ Depends ★★
Minerals	Beans, Liver	★★ Depends ★★	Every process at body	★★ Depends ★★

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Vitamins

- **Vitamin A (Fat Soluble):**
  - Sources: Green vegetables, Liver
  - Deficiency: Nyctalopia
  - Function 1: Keeps skin + hair healthy
  - Function 2: Aids in night vision

- **Vitamin B-Complex (Water Soluble):**
  - Sources: Peas, Wheat
  - Deficiency: Vitamin B-12 Deficiency
  - Function 1: Utilises body energy
  - Function 2: Helps brain/nerves be strong

- **Vitamin C (Water Soluble):**
  - Sources: Citrus fruits, Kiwi
  - Deficiency: Scurvy
  - Function 1: Heal Wounds
  - Function 2: Fight Infections

- **Vitamin D (Fat Soluble):**
  - Sources: Yolk, Salmon
  - Deficiency: Rickets
  - Function 1: Utilise calcium/phosphorus
  - Function 2: Build strong bones/teeth

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- **Vitamin E (Fat Soluble):**
  - Sources: Vegetable oils, Nuts
  - Deficiency: Abetallipoproteinemia
  - Function 1: Antioxidant
  - Function 2: Enzymatic Regulation

- **Vitamin K (Fat Soluble):**
  - Sources: Kale, Spinach
  - Deficiency: Vitamin K Deficiency
  - Function 1: Regulation of blood clotting
  - Function 2: Response to injury

Minerals:

- **Calcium:**
  - Sources: Milk, Cheese
  - Deficiency: Osteoporosis
  - Function 1: Helps heart be strong
  - Function 2: Helps bones be strong

- **Potassium:**
  - Sources: Squash, Potatoes
  - Deficiency: Hypokalemia
  - Function 1: Balance of food/electrolyte
  - Function 2: Function of living cells.

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- **Sodium:**
  - Sources: Celery, Beetroot
  - Deficiency: Hyponatremia
  - Function 1: Balance of fluids
  - Function 2: Transmit nerve signals

- **Magnesium:**
  - Sources: Spinach, Almonds
  - Deficiency: Magnesium Deficiency
  - Function 1: For biochemical reactions
  - Function 2: Heartbeat Steadiness

- **Phosphorus:**
  - Sources: Milk, Beans
  - Deficiency: Rickets
  - Function 1: Growth of tissues
  - Function 2: Bone structure/strength

- **Chloride:**
  - Sources: Table Salt, Tomatoes
  - Deficiency: Fluid loss (dehydration, Vomiting)
  - Function 1: Osmotic pressure of fluids
  - Function 2: Acid-Base Balance

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- **Iron:**
  - Sources: Liver, Fish
  - Deficiency: Anemia
  - Function 1: Making Hemoglobin
  - Function 2: Use of Oxygen

- **Manganese:**
  - Sources: Beans, Seeds.
  - Deficiency: Manganese Deficiency
  - Function 1: Fat/Carbs Metabolism
  - Function 2: Blood Sugar Regulation

- **Iodine:**
  - Sources: Cranberries, Kelp
  - Deficiency: Goiter
  - Function 1: Thyroid functioning
  - Function 2: Conversion of food to energy

- **Chromium:**
  - Sources: Bread, Broccoli
  - Deficiency: Diabetes
  - Function 1: Fat/carbs Metabolism
  - Function 2: Insulin action

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- **Fluoride:**
  - Sources: Walnuts, Cocoa Powder
  - Deficiency: Tooth Decay
  - Function 1: Mineralization of teeth
  - Function 2: Mineralization of bones

- **Copper:**
  - Sources: Potatoes, Offal
  - Deficiency: Wilson Disease
  - Function 1: Proper Growth
  - Function 2: Maintenance of organs

- **Selenium:**
  - Sources: Sardines, Beef
  - Deficiency: Hypothyroidism
  - Function 1: Making antioxidant enzymes
  - Function 2: Preventing cell damage

- **Molybdenum:**
  - Sources: Beans, Lentils
  - Deficiency: Molybdenum deficiency
  - Function 1: Catalyst for enzymes
  - Function 2: Catalyze amino acids with sulfur

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- **Zinc:**
  - Sources: Oysters, Red meat
  - Deficiency: Diarrhea
  - Function 1: For immune system to work
  - Function 2: Senses of smell and taste

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- Having looked at the types of food, the digestive system is not hard to understand.

- The digestive system has to do with the process of consumption and breaking down of food and nutrition in our bodies. Digestion is both chemical and mechanical. Its phases include:
  - Ingestion (swallowing food)
  - Movement
  - Mechanical/Chemical Digestion
  - Absorption (nutrients moving into cells)
  - Elimination (excretion - continued in excretory system).

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- The GI tract (Gastrointestinal Tract) is the main pathway in the digestive system. It comprises of:
  - Mouth
    - Teeth
    - Epiglottis (flap-like structure that prevent food from going down the windpipe).
  - Esophagus
  - Stomach
  - Intestines
    - Small
    - Large
  - Rectum

- The Esophagus is a 10" long tube that secretes mucus, moves food from the throat using wave-like motion (peristalsis):

(wave-like motion due to contraction of tube muscles)

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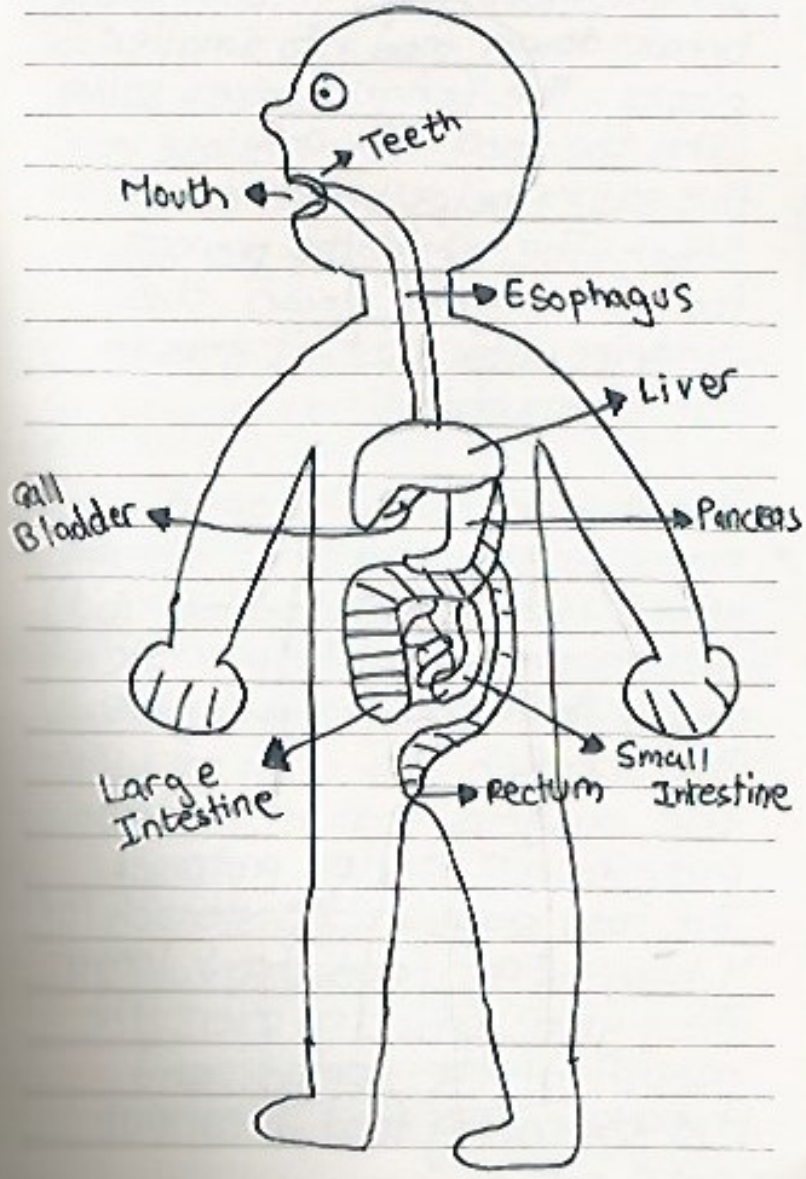

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- In the mouth, teeth mechanically break down food into smaller pieces. The tongue mixes saliva with the food. The amylase in the saliva helps break down starch. The epiglottis prevents food from going down the windpipe, after that, it goes to the stomach.

- The stomach is a J-shaped muscular sac that has digestive juices (such as Hydrochloric Acid) with enzymes that help break down Proteins/Polypeptides. The stomach has a pH of 1.5. The enzymes that break down proteins are called proteases. The food stays in the stomach for 4 hours. Fast food stays longer. The pyloric sphincter covers the mouth of the stomach, and the churning food does not come out.

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- After 4 hours in the stomach, the food (which most of has been digested anyway), the food moves to the small intestine. This is the longest single organ of the body. The food is digested using pancreatic amylase. It has small, finger like projections (villi), which themselves have smaller versions of themselves (microvilli). They aid in increasing the Surface Area to Volume Ratio. Within the small intestine lacteals (lymphatic vessels) absorb fats. The small intestine absorbs:
  - 80% ingested water
  - Carbohydrates
  - Proteins/Polypeptides
  - Fats/Lipids
  - Vitams
  - Minerals

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- The large intestine accepts what the small does not. The bacteria in the large intestine ferment carbohydrates and break down proteins. The large intestine continues to the rectum, where food is excreted in the form of faeces.

- Accessory organs are organs which play indirect roles in an organ system.

- The Liver affects digestion in the following ways.
  - Emulsifies fats. The liver breaks down the fats into many smaller pieces. This increased surface area allows for sped up digestion.
  - Filters toxins, that leave the body as urea (partides that make urine yellow)
  - Secretes bile (made of

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worn out Red Blood Cells) that helps in digestion of fats.

- The Gall Bladder stores this bile, and releases it into the small intestine when necessary.
  - Too many fatty diets can cause gallstones.

- The pancreas produces digestive enzymes (biological catalysts) that help break down proteins and lipids. It also produces insulin, which regulates blood sugar levels.

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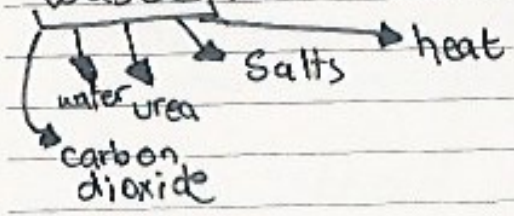
- The Digestive System is closely tied with the Excretory System. This has to do with releasing waste from the body.



- The Excretory System removes harmful and waste products from the body. While a major component of this system is the urinary system, the excretory system is not solely based on it, and includes:
  - Lungs
  - Liver
  - Sweat Glands
  - Kidneys
  - Small Intestine
  - Large intestine
  - Etc.

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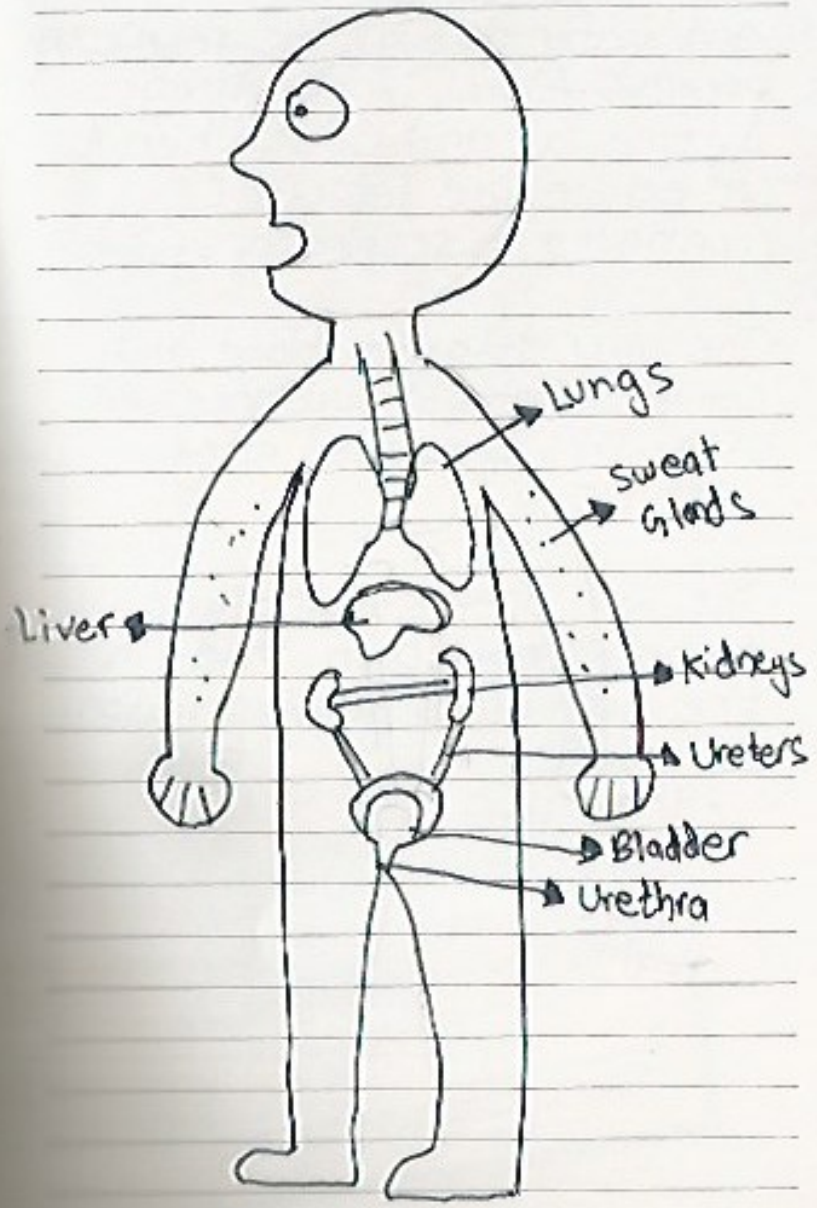

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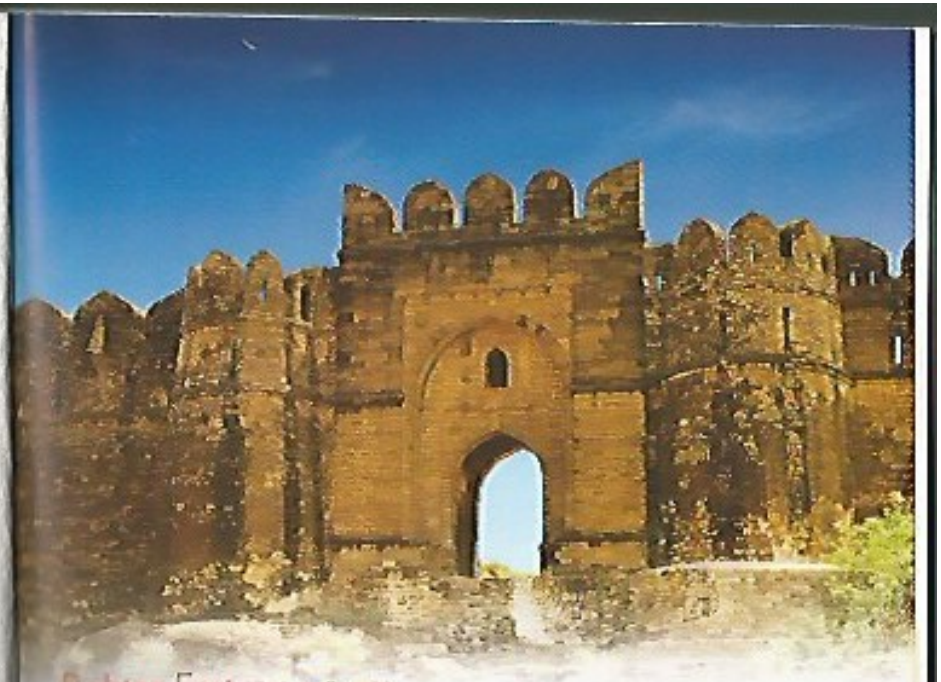
- The lungs excrete carbon dioxide and water through the respiratory process. Alveoli in the lungs diffuse air and CO_2. When we exhale, we let out CO_2. (continued in respiratory system)

- The Liver detoxifies blood and converts harmful substances into urea. This is excreted along with urine.

- The skin uses sweat glands to help cool down body in the form of sweat/perspiration. It includes:
  - 99% H_2O
  - Salts
  - Urea
  - Heat



Rohtas Fort (Jhelum, Punjab)

Rohtas Fort was built by Pashtun King Shar Shah Sun in the 16th century. Located near the city of Jhelum in the Pakistani province of Punjab, the fortress was constructed to help subdue the rebellious tribes that were loyal to the Mughal crown. It ensured safety, security and formidability amidst threats and dangers to the Pashtun Empire.

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• The kidneys are the most important part of the excretory system. They are fist-sized and bean-shaped. They have two million nephrons in total that filter the blood of toxins. At the end of each nephron is a Glomerulus (a clump of capillaries) that diffuse wastes out of the body. Homeostasis (maintenance of an internal environment) must be maintained, else problems like Bladder/kidney infections, Kidney stones, Kidney Disease, Gout etc. After the kidney, other parts of the urinary system come into play!

• The ureters are narrow tubes which connect the kidneys to the bladder, a muscular sac that stores urine. Through the urethra (a tube leading from the body), urine is excreted out of the body.

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- Large Intestines / Small Intestines play roles in the expulsion of faeces. The small intestine leads to the large intestine, which leads to the rectum and then the anus, from where food is expelled in the form of faeces.

X

- The Circulatory System is an organ system that is a fluid-filled network of vessels through which materials move between the environment of an organism.

- Types of circulatory systems:
  - Open: Insects, Anthropods
  - Closed:
    - Fish and small mammals (single)
    - Humans (double)

- The circulatory system transports Oxygen and Glucose into cells, and removes CO_2 and Urea.

Date: - -

- Components:
  - Heart
  - Blood Vessels
    - Arteries (tubes carrying oxygenated blood away from the heart)
    - Veins (tubes carrying deoxygenated blood back to the heart.
    - Capillaries (mesh of single-cell thick tubes that are the actual site of diffusion).
  - Blood
    - Red Blood Cells (transport)
    - White Blood Cells (Immune Defense)
    - Platelets (clotting)
    - Plasma (medium for transport)

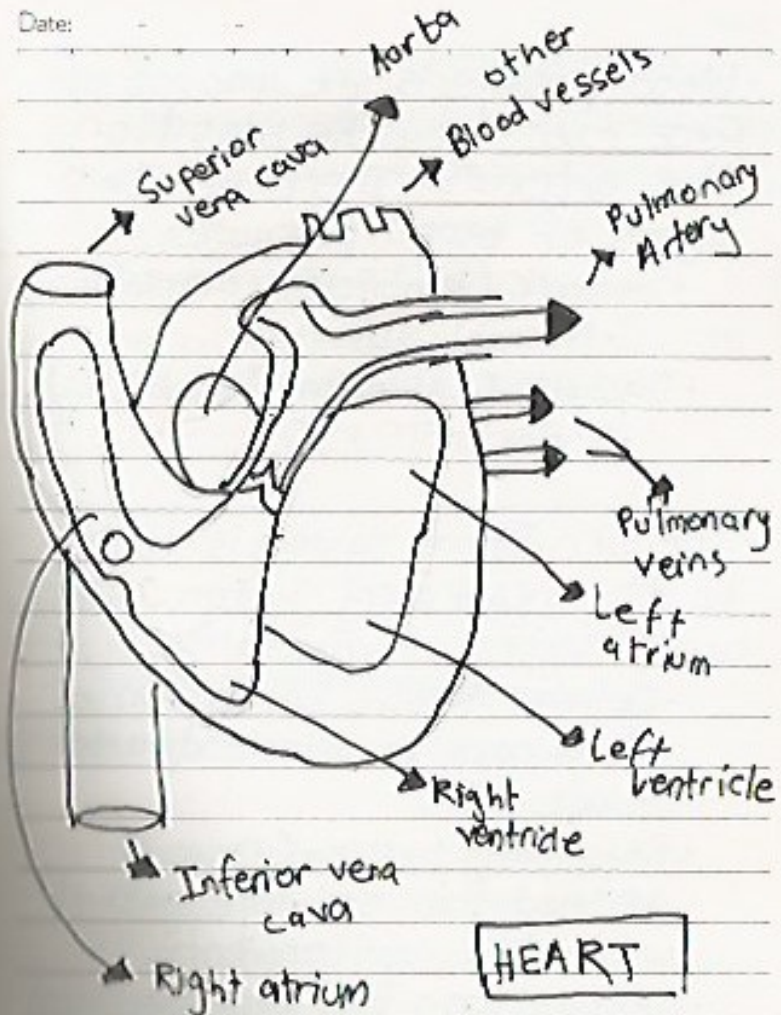
Arteries	Veins	Capillaries
Small Lumen	Large lumen	Small Lumen
Reddish	Bluish	Purplish
Elastic	Inelastic	Unknown
No valves	Valves	NO valves
Thick	Thick	single-cell thick

Date: - -

- Veins have valves so that the blood coming back from various parts of the body does not flow back. Arteries do not have valves because the blood flow rate from the heart is already very high.

- Important vessels:
  - Pulmonary Artery (Heart → Lungs)
    - This is deoxygenated blood (only exception for artery)
  - Pulmonary Vein (Lungs → Heart)
    - This is oxygenated blood (only exception for vein)
  - Aortic arch and trunk (main arteries from heart)
  - Common carotid artery (blood to brain)
  - Renal vein/artery - connect to kidneys
  - Mesentric vein - Connect to intestine
  - Hepatic portal vein - Blood from GI tract to liver

Date: - -



HEART

- Accessory organs
  - Lungs: O_2 taken in, CO_2 released
  - Kidneys: Where waste is removed
  - Small Intestine: Digestion
  - Large Intestine: Absorbing water

Date: - -

- Blood pressure is the amount of force exerted by the blood on the arteries. There are two types of blood pressure:
  - Systolic (ventricles contraction)
    - Norngal: 110 -140
  - Diastolic (expansion of ventricles)
    - Normal: 70:90

X

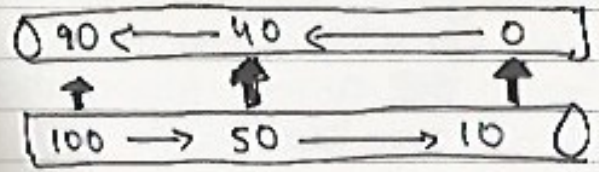
- The circulatory system is tied to the respiratory system. There are 3 types of respiration:
  - Cellular: Aerobic breakdown of of glucose in mitochondria to make ATP.
  - Respiratory system: Organs in animals that exchange gasses with the environment.
  - Respiration: The everyday word used interchangably with breathing

- Respiratory systems allow animals to move oxygen into body tissues and remove CO_2.

Date: - -

- Structures for respiration:
  - Aquatic: Gills
  - Insects: Spiracles
  - Vertebrates: Lungs

- Type of exchange: Countercurrent



- Equilibrium is not reached, so more CO_2 can be excreted.

- Components:
  - Trachea
  - Bronchi
  - Bronchioles
  - Alveoli
  - Diaphragm
  - Lungs

Date:

- Nasal and Buccal Cavity - where air enters the body via the nose and mouth.

- Move to pharynx and Larynx (throat cavity and voice box respectively) through epiglottis (flap-like structure that stops food from going down the respiratory tract.

- Trachea is a large tube reinforced by rings of cartilage. Mucus in the trachea constantly traps inhaled particles. Cilia, small, hair-like structures inside the trachea, sweep mucus and inhaled particles to the pharynx - it's what we spit out.

- Trachea are lined with smaller tubes called bronchi - these shuttle air to and from the lungs. They are lined with bronchioles which ensure air is provided

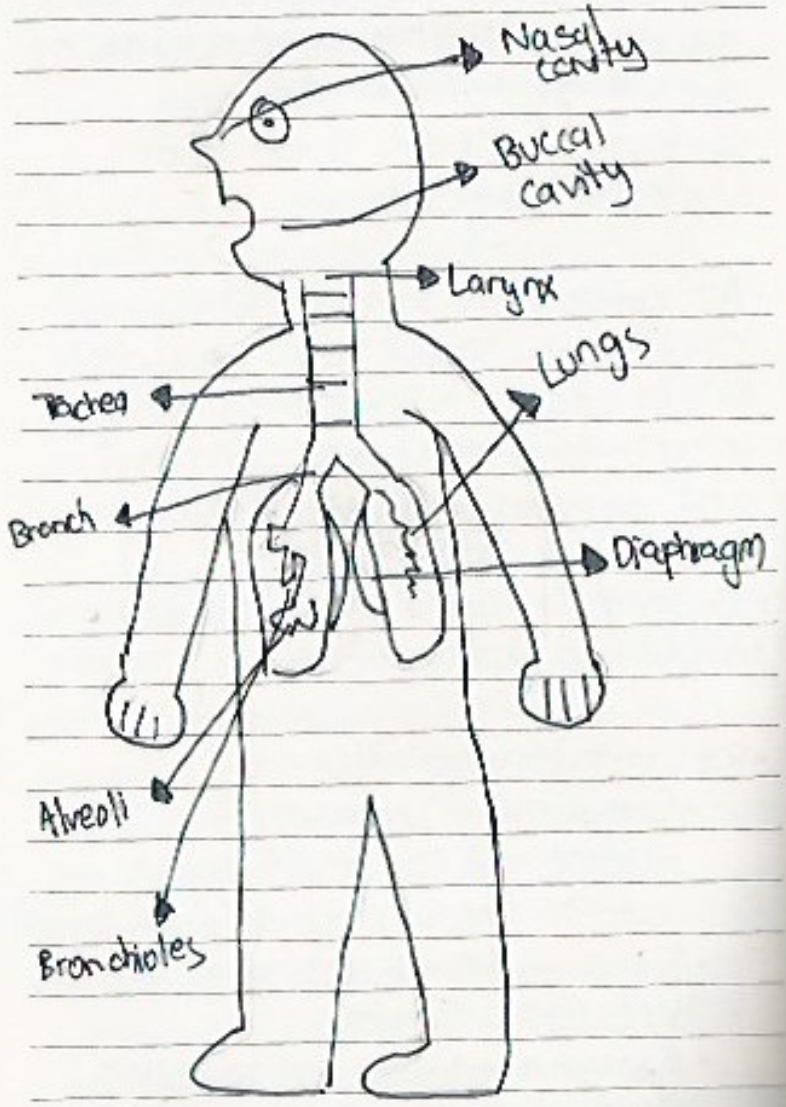
Date:

to alveoli (moist, thin-walled pockets that are the site of gas exchange. An oily surfactant keeps them from sticking together.

- Air comes in through the Diaphragm. These are muscles in rib cages. When they and intercostal muscles contract and expand, air is inhaled and exhaled. Gas exchange of CO_2 and O_2 take place of both lungs and body cells.

- Respiratory problems:
  - Smoking - Increased tar, nicotine and CO_2 inside, cause cancer and emphysema (alveoli dry up)
  - Bronchitis - Swelling of bronchi due to infection
  - Asthma - Bronchial swelling and blockage.

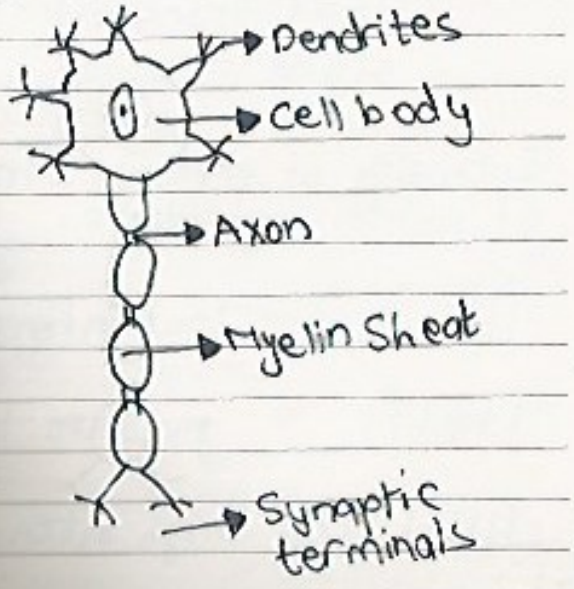
Date:



Date:

- Steps:
  - Contraction of Diaphragm
  - Air inhaled through nose/mouth
  - Trachea cilla clean air
  - Diffusion takes place.
  - Diaphragm expands
  - Air exhaled

- The nervous system has to do with the transferral of signals to the brain and its functions. The neuron cell is what does most of this.



Date: - -

- Functions:
  - Dendrites receive signals from other cells.
  - Cell body integrates signals.
  - Axon transmits action potential
  - Myelin sheath speeds up transmission
  - Synaptic terminals transmit signals to elsewhere.
    - Neurons do not usually directly - they have gaps called synaptic terminals that transmit the signal.

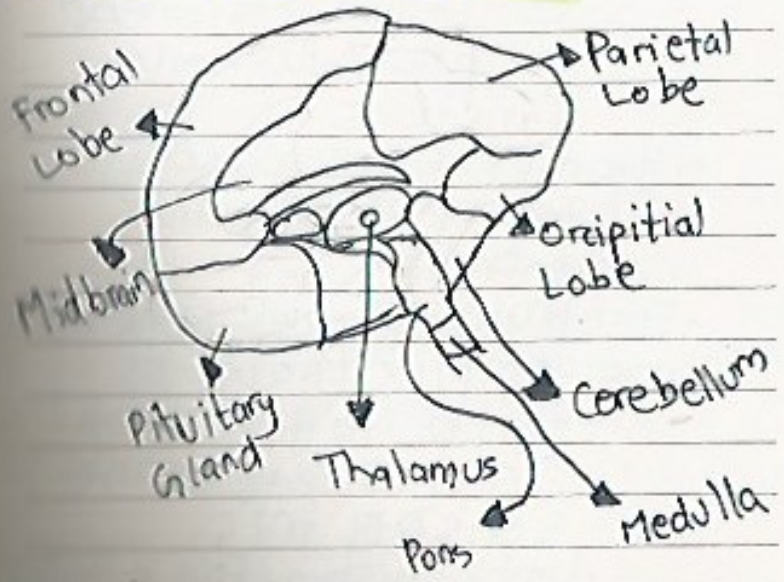
- Intensity of stimulus = frequency of action potentials.

| | |	low intensity
| | | | | |	medium intensity
| | | | | | | | | | |	high intensity

Date: - -

- Neural pathways consist of:
  - Sensory Neurons
  - Association Neurons
  - Motor neutrons
  - Effectors

- The simplest neural pathway is the reflex arc. They carry out the reflex in association with the spine before the brain even knows about it.



Date:

~~•Sections of mind:~~
~~•Forebrain: Stores memories and complex thoughts~~
~~•Pons: Sleep~~
~~•Cerebellum: Movement~~
~~•Medulla: Autonomic functions~~

- Sections of mind:
  - Hindbrain: Basic functions
    - Pons: Sleep
    - Cerebellum. Movement
    - Medulla: Autonomic functions
  - Midbrain: Filters sensory input, allowing concentration
  - Forebrain: Stores memories and complex thoughts.
    - Cortex: Higher thought
    - Thalamus: Channel sensory info
    - Limbic system: Basic feelings

Date:

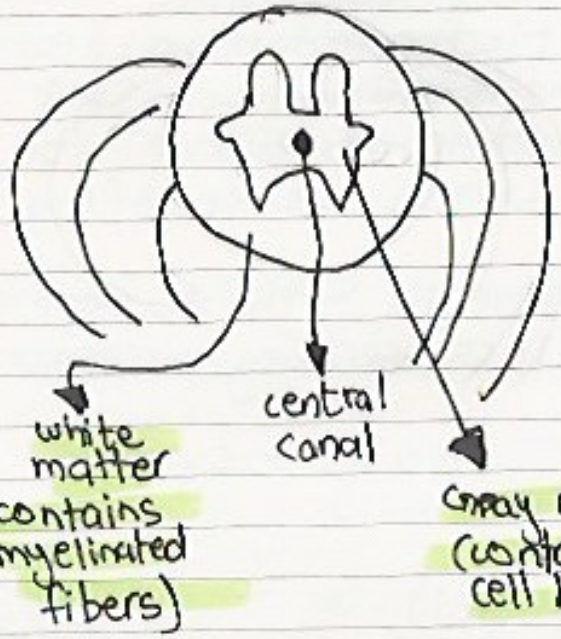
- Human Senses:
  - Thermoreception: Changes in temperature felt
  - Mechanoreception: Hearing
  - Photoreception: Sight
  - Chemoreception: Taste, smell, sense of pain.

- Synthesia is the development of cross-sensory perceptions.

- Nervous system
  - CNS (central)
    - Brain
      - Receives sensory signals and determines responses
      - Stores memory
      - Carries thought
    - spine
  - PNS (Peripheral)
    - Motor neurons
      - Somatic
      - Autonomic
    - Sensory Neurons

Date:

- Spinal cord is protected by vertebrae



PNS extend outside vertebrae

X

- The immune system has to do with fighting bacteria, viruses and other microorganisms from harming the human body.

Date:

- Functions:
  - Communication
  - Killing enemies
  - Standby mode
  - Fighting worms
  - Causing inflammation
  - Activating other cells
  - Producing antibodies
  - Killing infected cells
  - Making strategic decisions
  - Remembering enemies
  - Marking/disabling enemies

- Cells involved/Protein forces:
  - Macrophages
  - Eosinophils
  - Neutrophils
  - Basophils

  } white Blood cells

  - Natural killer cells
  - Complements
  - Mast Cells
  - Monocytes
  - Follicular Dendritic Cells
  - Dendritic cells
  - Memory helper T cell

Date: - -

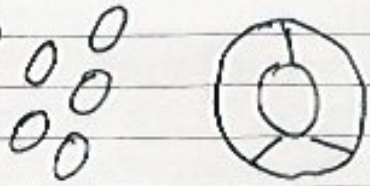
- Virgin helper T cells
- Helper T cells
- Memory Helper T stem cells
- Virgin Killer T cells
- Antibodies
- Killer T cells
- Memory Killer T cells
- Virgin B cells
- B cells
- Memory B stem cells
- Memory Killer T stem cells

- How the immune system works:

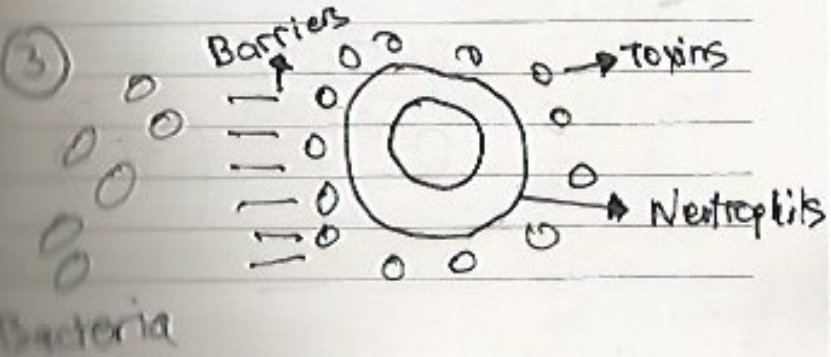
(1) 

Through a wound (such as by a nail), bacteria, viruses etc. enter the body, the skin is breached. They start using the body's resources, and double in number about every 20 minutes.

Date: - -

(2) 

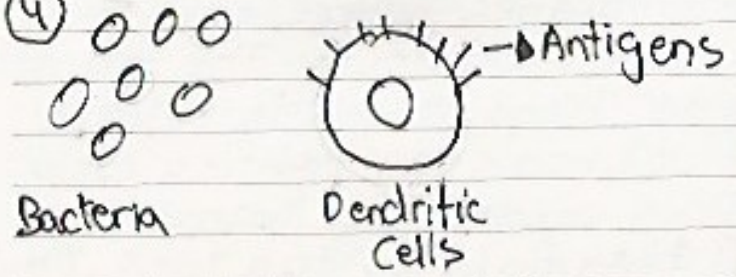
Macrophages intervene. Mostly, they alone can supress an attack. They swallow intruders whole and trap them inside membranes where enzymes break them down. The macrophages order blood vessels to release fluid, making fighting easier. This causes inflammation. If they fight for too long, they use messenger proteins that call in the next backup- Neutrophils.

(3) 

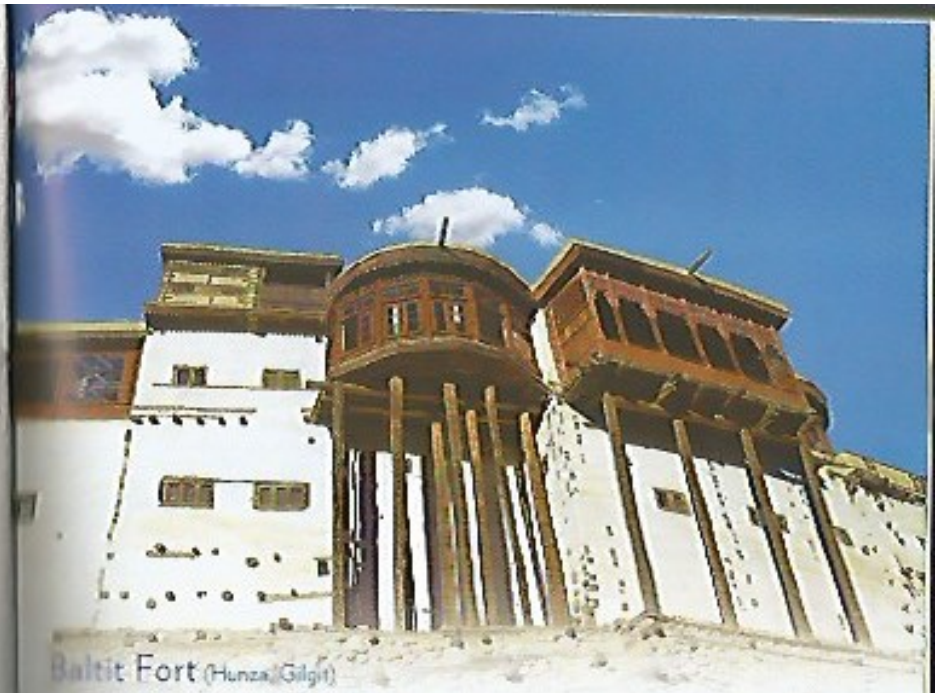
Date: - -

The neutrophils release toxins and create barries that try to stop the bacteria. They fight so furiously that they even kill healthy cells. They commit suicide after 5 days to prevent too much damage. If they cannot supress the attack, Dendritic cells take action.

(4)



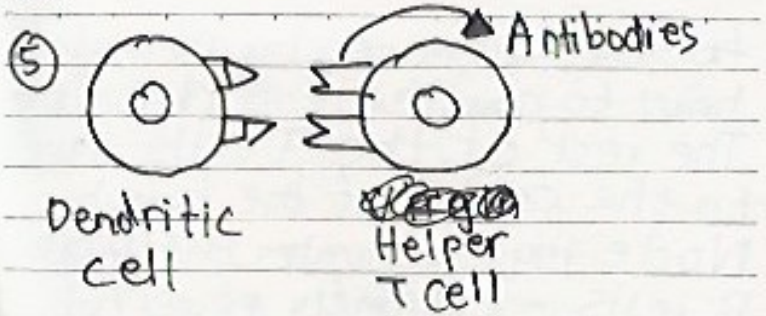
The dendritic cells take samples of the intruders and travel to the lymph node in about a day, where helper and killer T cells are waiting to be activated.



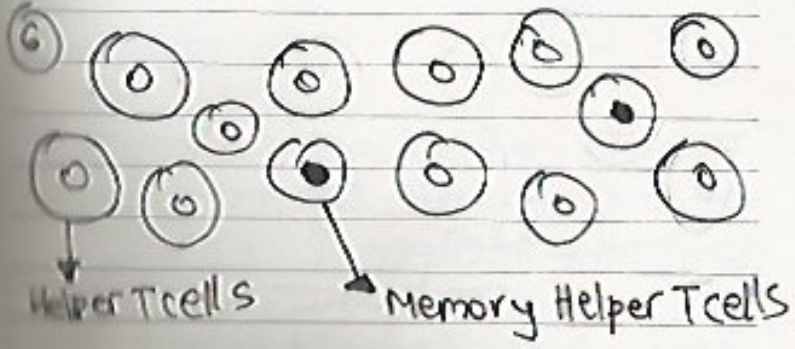
Baltit Fort (Hunza/Gilgit)

Baltit Fort was founded in the 8th century in the Hunza valley in Gilgit-Baltistan. The fort was built as a means of protecting the feucal regime of Hunza. It was also where the Hunza regrouped and planned all their directives during their rule.

Date: - -



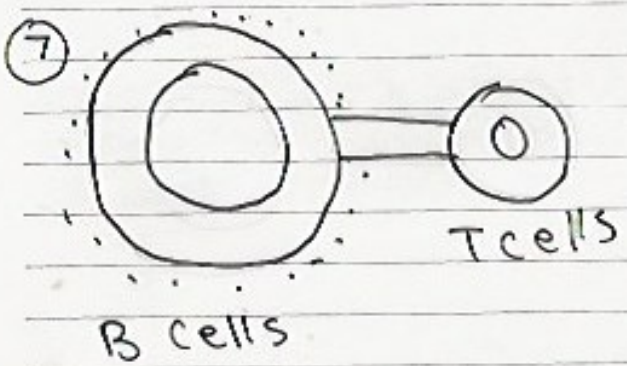
The Helper T cells are born through a difficult manufacturing process where only 1/4 survive. The dendritic cell looks for T cells that have antibodies that fit right into the antigens.



The Helper T cells multiply, some becoming the Memory Helper T cells. They stay in the Lymph Node, and make you immune

Date:

to the disease by remembering how to counter it in the future. The rest of the T cells travel to the center of the Lymph Node that activates the (virgin) B cells - extremely powerful weapons.



The B cells fight so hard that they die of exhaustion, but the Helper T cells provide resources and stop them from doing so. The B cells produces millions of weapons - antibodies. The B cells die once the infection is over, to stop the

Date:

body from loosing too much energy. The antibodies (proteins) attack in billions to the bacteria, killing | stunning them. Macrophages are especially useful for killing these stunned bacteria. The cells commit suicide so as not to waste body resources. However, the memory cells (T and B) stay alive and remember how to counter the same enemy again - but very easily.

- Knowing how the immune system works, understanding vaccination is not that hard.

- A vaccine is a medication for a disease that immunizes the patient against a disease.

Date:

- Types of immunization:
  - Passive:
    - Natural: Passed from mother to child before birth.
    - Artificial: Prepared antibodies injected using serum
  - Active:
    - Natural: Naturally acquired immunity through activation of antibodies
    - Artificial: Achieved by vaccines / toxoids

- Types of vaccines:
  - Live-attenuated: Strains of weakened pathogens
  - Heterologous: Sub-group of Live-attenuated vaccines of pathogenic organisms in animals (not humans)
  - Inactive / Killed: Bacteria / viruses are killed for this

Date:

  - Sub-unit: Are made up of only antigens (the part of the pathogen responsible for immune response).
  - Toxoid: Used when a bacterial toxin is the main cause of illness.
  - Peptide: Subunit vaccine prepared by chemical synthesis of short immunogenic peptides.

- The first ever vaccine was created by Edward Jenner for smallpox using cowpox.

- The endocrine system has to do with the release of hormones in the body. Hormones are chemical substances that help achieve homeostasis (a general sense of the maintenance of an internal body environment.

Date: - -

- Homeostasis levels:
  - Water Balance:
    - 90% of blood volume
  - CO_2 concentration:
    - 10 - 13 KPa
  - Body temperature:
    - 36°C – 38°C
  - Blood Glucose Concentration
    - 80 mg dl^{-1} – 110 mg dl^{-1}
  - Blood pH:
    - pH 7.35 – 7.45

- Examples of body hormones:

- Insulin (secreted by beta cells of the pancreas) causes the glucose to turn into glycogen. This decreases blood sugar levels.

- Glucagon (secreted by alpha cells of the pancreas) does the opposite. It convert glycogen to glucose.

Date: - -

- Thyroxin is secreted by the thyroid gland to regulate the metabolic rate and help control body temperature.

- Leptin is secreted by cells in the adipose tissue that controls desire for food/appetite.

- Melatonin is sereted by the pineal glands and controls sleepiness. More light = less sleepiness.

- Testosterone causes sperm production and development of male secondary sexual characteristics in puberty.

- Oestrogen and progesterone causes during female secondary sexual characteristics.

Date: - -

- Feedback loops:
  - Negative: Feedback causes hormones to maintain homeostasis by ordering to increase/decrease levels accordingly.
  - Positive: Increased rise

X

X

Date: - ECOLOGY

- Arrangement Levels:
  - Organisms
  - Species
  - Populations
  - Communities
  - Ecosystems
  - Biomes
  - Biospheres:
    - Atmosphere (Air)
    - Lithosphere (Land)
    - Hydrosphere (Water)

- Ecology is the study of relationships between living organisms and other organisms and the environment.

- Based on feeding patterns, there are 2 types of organisms:
  - Autotrophs: Produce their own food
  - Heterotrophs: Consume others

Date: - -

Feeding Methods

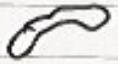
- **Autotrophs**
  - Producers
    - Photo autotrops (photosynthesis)
    - chemo autotrophs (chemosynthesis)
- **Heterotrophs**
  - Consumers
    - Primary consume producers
    - secondary consume other consumers
  - Decomposers
    - Detritivores
      - Ingest non-living organic matter
      - Detritus means dead matter
    - saprotrophs
      - Secrete digestive enzymes, then digest those

Date: - -

- The highest level of predators are always fewer in number - it is nature's way of protecting and ensuring balance.

- Energy in a food chain goes waste and cannot be recycled. Only 10% of energy is passed on to a consumer:

Plants (producers)  100% energy

worms (primary consumers)  10 % energy

birds (secondary consumers)  1% energy

Date: - -

- There are 2 types of factors that affect an ecosystem:
  - Abiotic (non-living)
    - Light
    - Climate
    - Temperature

    etc.
  - Biotic (living)
    - Organic matter
    - Consumers
    - Producers

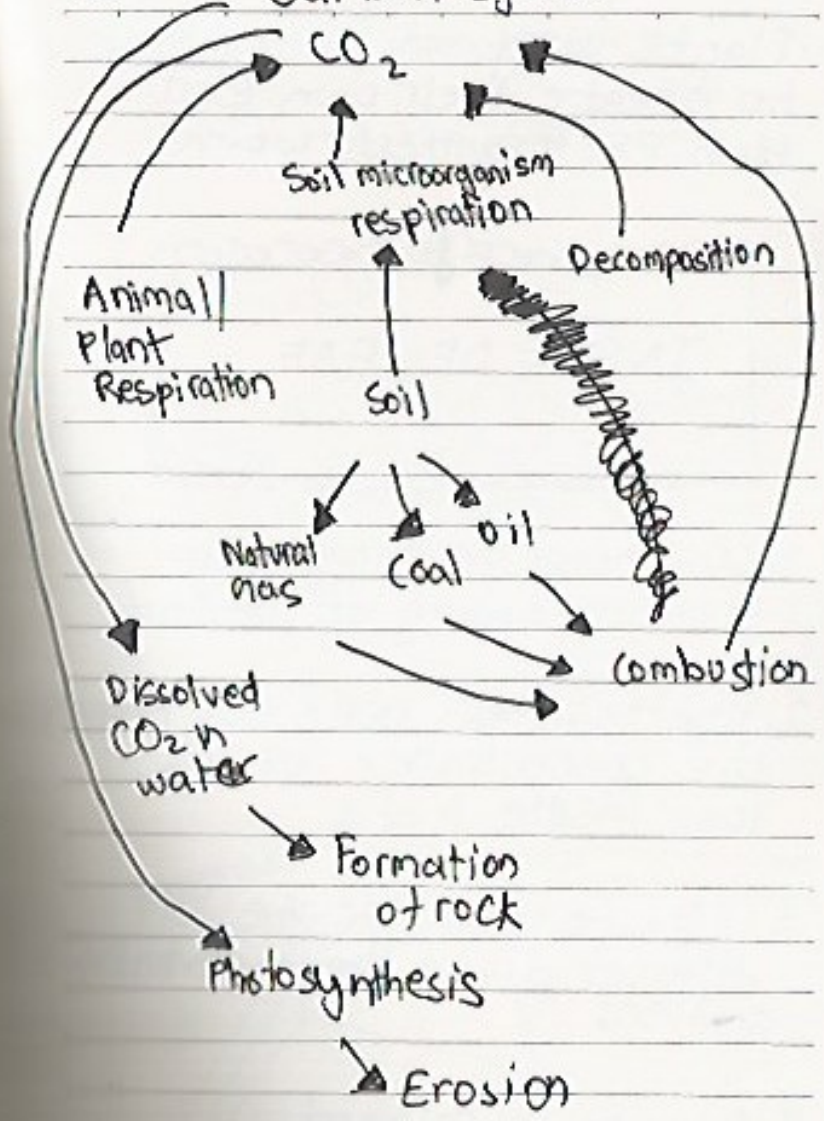
    etc.

- Factors controlling an ecosystem:
  - Nutrients: (closed system)
    - Carbon
    - Nitrogen
    - Phosphorus
  - Energy (open system)
  - Interactions between species

- The cycling of these nutrients is critical for life on earth:
  - All proteins and air have Nitrogen
  - All cells have ATP (phosphates)
  - Carbon gives energy

Date: -

Carbon cycle

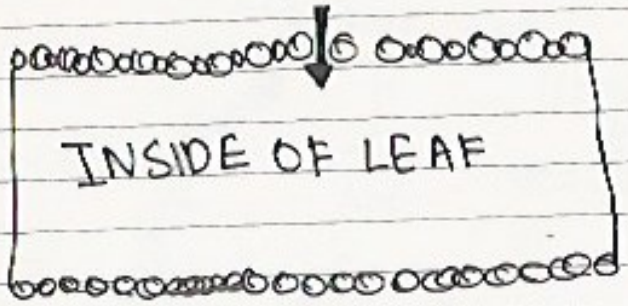


IT IS A CLOSED CYCLE

Date: - -

- Plants carry out photosynthesis to create their own food.

How Photosynthesis works:



1. CO_2 moves in through the stomata opening of the leaf.

2. Photosynthesis uses CO_2 keeping the concentration of CO_2 low inside leaf.

3. CO_2 from outside the left diffuses down the concentration gradient

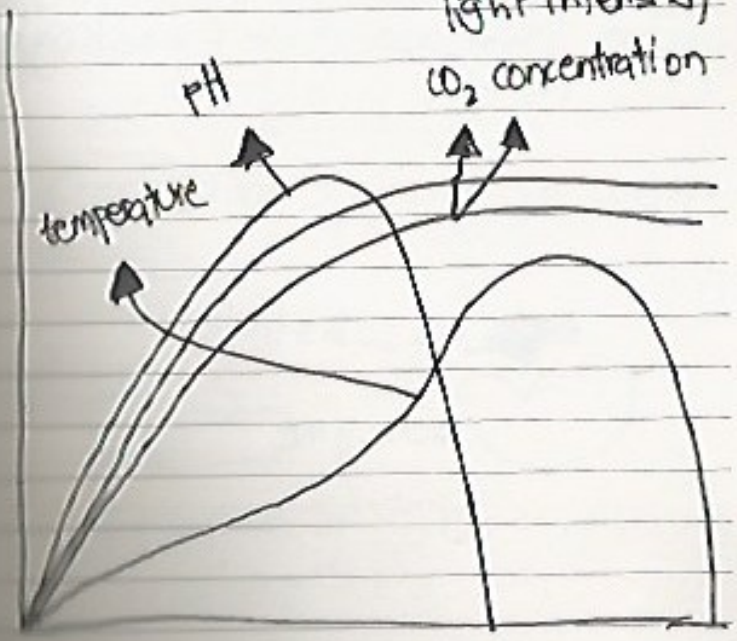
4. Oxygen is released.

Date: - -

- Formula for Photosynthesis:

$$6CO_2 + 6H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

- Factors affecting Photosynthesis:
  - CO_2 concentration
  - Light intensity
  - Temperature
  - pH



Date: - -

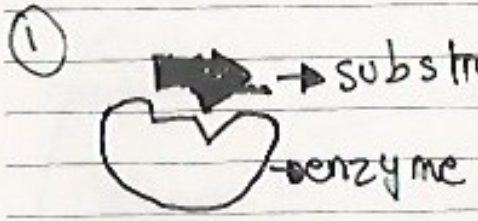
- Rate of photosynthesis is measured by:

$$\text{Rate} = \frac{\text{change}}{\text{time}}$$

- An enzyme is a globular protein which acts as catalysts in biochemical reactions.

- A substrate is the reactant in a biochemical reaction. In the case of photosynthesis, CO_2 is the substrate.

- How an enzyme works:



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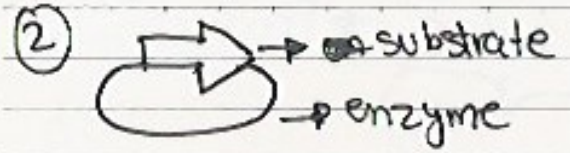
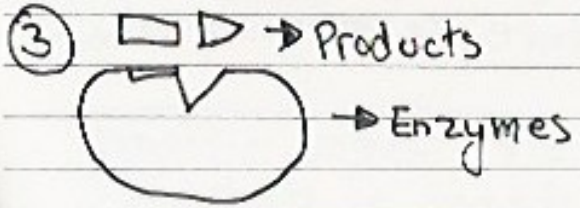
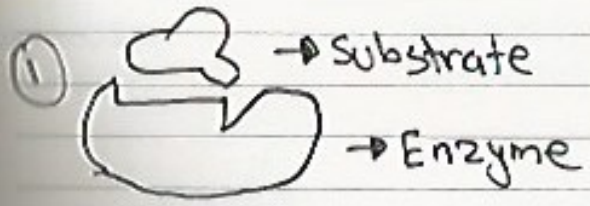


substrate attaches

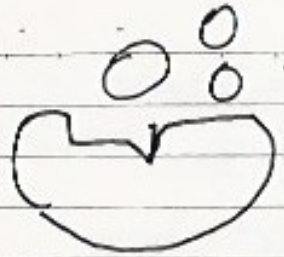


- But, an enzyme can also produce products that sometimes do not match its shape. This is called the induced fit model.



Enzyme changes shape

Date

③  → Products

Enzyme reverts to shape, releases products.

X

- There are several different types of plants

- Non-vascular (no conductive tissues)
- Vascular (conductive tissues)
  - Spermatophytes (give seeds)
    - Angio (flowering plants)
      - Monocots
      - Dicots
    - Gymno
  - Filicophytes (no seeds)

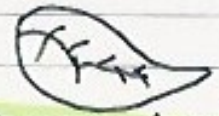
Date

Monocots vs. Dicots

Petals in multiples of 3

Petals in multiples of 4 or 5

Parallel veins in leaves



Branched veins in leaves

Random distribution of vascular tissues in stem

Arranged vascular tissues

♂ after germination ♀

One cotyledon

Straight/Adventitious roots

Two cotyledons

Branched roots

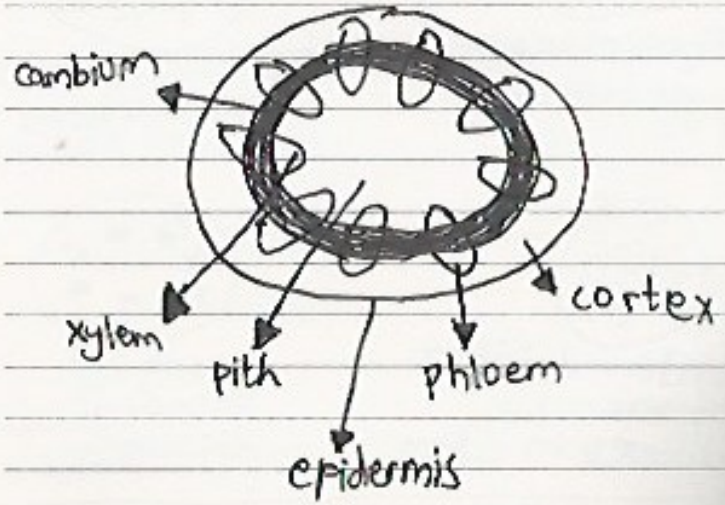
Date: - -

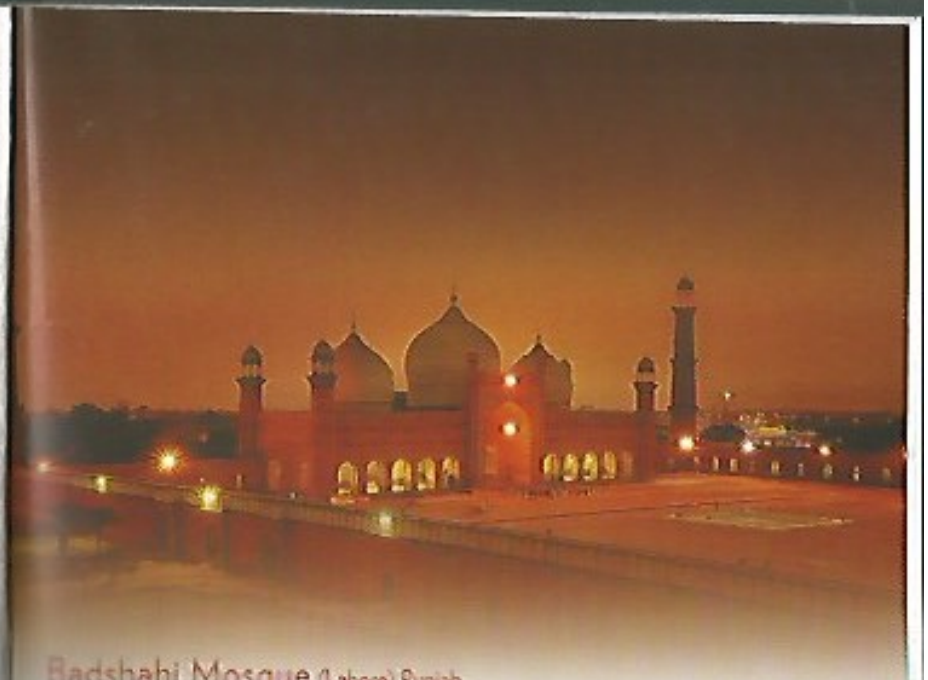
- There are 2 main vascular tissues – Xylem and Phloem.

- Xylem transports water, Phloem transports food.

PHloem = Food

- Dicots cross-section





Badshahi Mosque (Lahore) Punjab

The Great Badshahi Mosque is one of the oldest mosques of the region. It was built in the Mughal Era by the Great Emperor Aurangzeb. It was constructed in the year 1671. Today it is the second largest mosque in the country after Shah Faisal Mosque. It can accommodate up to 100,000 worshippers at a time.

Date: - -

Xylem	Phloem
Transports water	Transports food
Three elements dead, one alive	Three elements alive, one dead
Sieve ~~plates~~ absent	Sieve ~~cells~~ present
Xylem provides mechanical strength	Phloem provides no mechanical function
Movement is unidirectional	Movement is multidirectional
Not influenced by metabolic inhibitors	Influenced by metabolic inhibitors

Tropism is a plant's responses to directional external stimuli. They can positive (towards stimulus) or negative (away from stimulus). Plant growth is regulated by hormones called auxins.

Date: - -

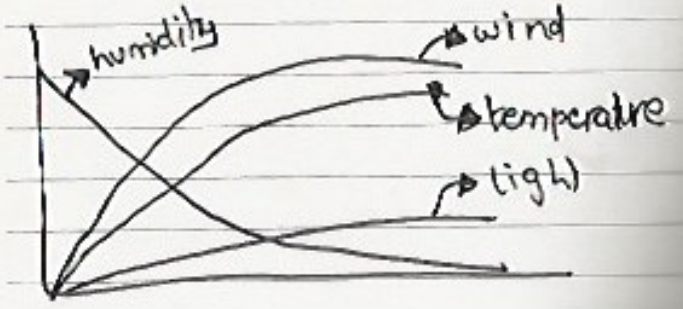
- Transpiration is the loss of water from leaves and stems of plants. Xylem transports the water. This process helps cool down the plant and the atmosphere. Transpiration flow is controlled by the rate of water loss through the stomata.

- [illegible]

- CO_2 uptake ∝ Water uptake

- The hormone absisic acid is produced to close stomata.

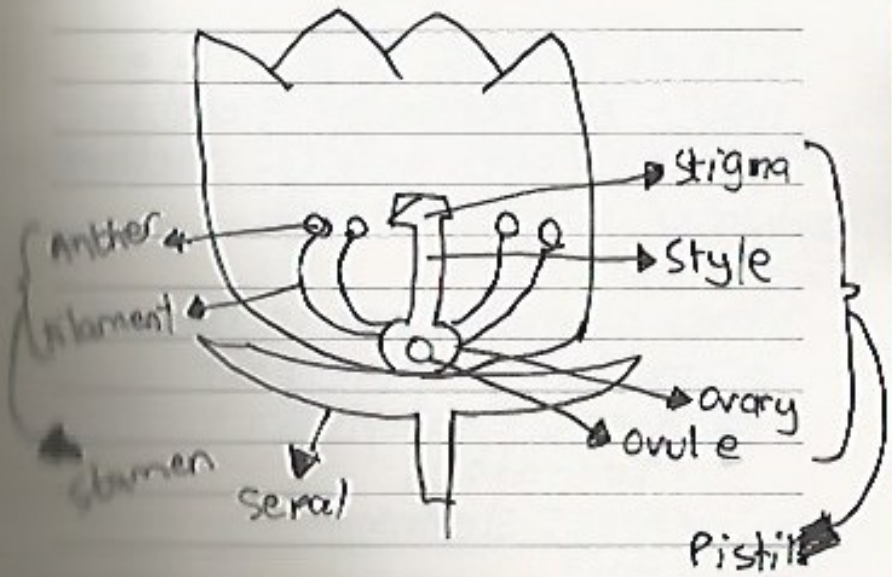
- Factors affecting rates of transpiration:



Date: - -

- Plant reproduction:
  - Sexual
    - Self Pollinated
    - Cross Pollinated
  - Asexual
    - Budding
    - Vegetative Propagation

- Parts of a flower:



X

Date: - -

- Climate change has been prevalent ever since the discovery of coal, natural gas and other fossil fuels.

- Climate IS NOT weather. Climate is the average weather at a given point in a year, over a long period of time, typically 30 years.

- Climate change is mostly a result of increasing greenhouse gasses (such as CO_2, Methane, Water Vapour etc.)

- The climate has increased dramatically in the past 100 years. Examples:
  - Tornadoes
  - Dust storms
  - Hail
  - Lightning
  - Etc.

Date: - GENES AND DNA

- DNA stands for Deoxyribonucleic acid. It is a macromolecule that contains the genetic code. It contains the code that determines the shape and structure of living organisms.

→ Double Helix Structure

DNA is made up of nucleotides. The structure/backbone is made of phosphates and sugars. The 4 bases determine the genetic code.

- There are 4 types of bases:

Adenine - Thymine (A < T) Bind together

Cytosine - Guanine (C < G) Bind together

Date: - -

- The order of the 4 bases determines the genetic code.

- A gene is a section of the DNA that codes for a specific trait, such as eye colour, skin colour etc.

- RNA, or Ribonucleic Acid is a polymeric molecule essential in various biological roles, including coding, decoding.

- DNA —(codes for)→ RNA —(codes for)→ Proteins
  (transcription) (translation)

RNA copies the genetic code from DNA

RNA decoded in ribosomes, the latter of which synthesize proteins.

Date: - -

- Alleles are alternative versions of a gene. They come from either parent.

- The DNA in cells is not stored as one long strand, but is divided and coiled into certain individual lengths called Chromosomes. Humans have 23 pairs of chromosomes — one from each parent.

- If the order of the bases is changed, even to the slightest extent, a mutation takes place. This is caused by base exchange etc., or by mutagens. A mutation taking place in a gamete (sperm or egg) can be passed on to the next generation, whereas mutations in the body can be harmless or cause diseases like cancer. Examples of mutagens include X-rays, radiation, cigarettes etc.

-

Date: - -

- There are 3 main types of mutations: Insertion, Deletion and Substitution.

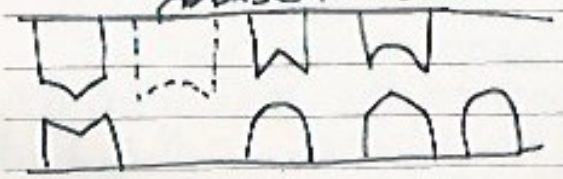
Original Gene:

all fit together

Insertion (adding a base):

do not fit

Deletion (removing a base):



do not fit

Date: - -

Substitution (exchanging bases):

some fit

- Side effects and examples of dangerous mutations:
  - Insertion
    - Huntington's Disease
    - Fragile X syndrome
  - Deletion
    - 22q11.2 deletion syndrome
  - Substitution
    - Sickle Cell Anemia

- Down syndrome is a genetic mutation in which a third copy of Chromosome 21 appears. It is associated with physical growth delays.

X

Date: - -

- Heredity refers to the transmission of physical characteristics from an organism to its offspring. Physical characteristics of the offspring are created by the mixing of physical characteristics of the parents, or sometimes further ancestors. The inheritance of these traits can be represented by a Punnett square. The concept of heredity was introduced by Gregor Mendel, who worked with peas.

- Punnet Square

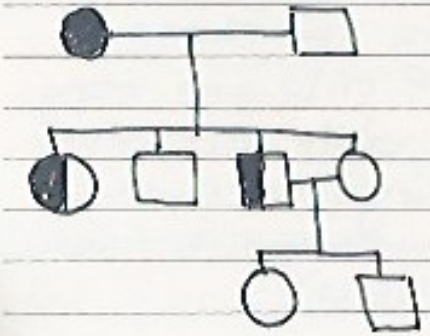
	X	x
X	XX	Xx
x	Xx	xx

dominant traits

Dominant traits are represented by capital letters, while recessive traits are shown by lowercase letters

Date: - -

- A pedigree chart can also be used:



Rules:
- Females are circles
- Males are squares
- Couples connected by a horizontal line.
- Oldest to youngest are from left-most to right-most respectively.
- Full-shaded shows person who shows trait
- Half-shaded represents trait carrier
- Blank has no trait

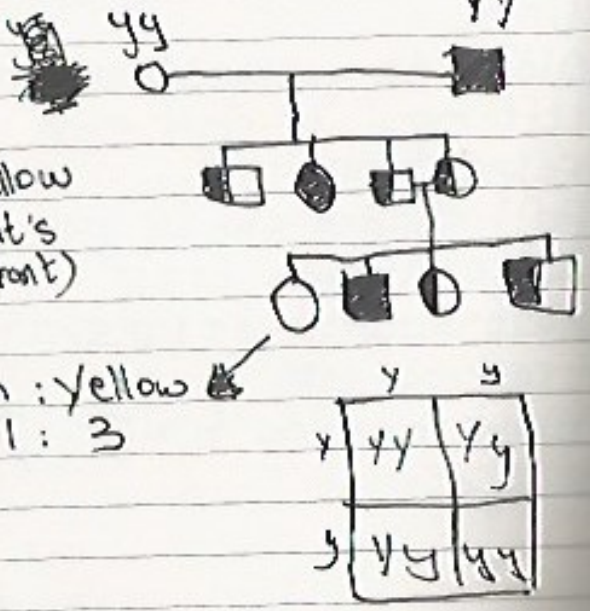
Date:

- There are 2 types of alleles: Dominant and Recessive. Dominant alleles are those which require only one copy to be shown, while recessive need both. They (recessive) need to be homozygous (same letter = same allele).

- Example:

Green Peas (recessive)

Yellow Peas (dominant)



All yellow (since it's dominant)

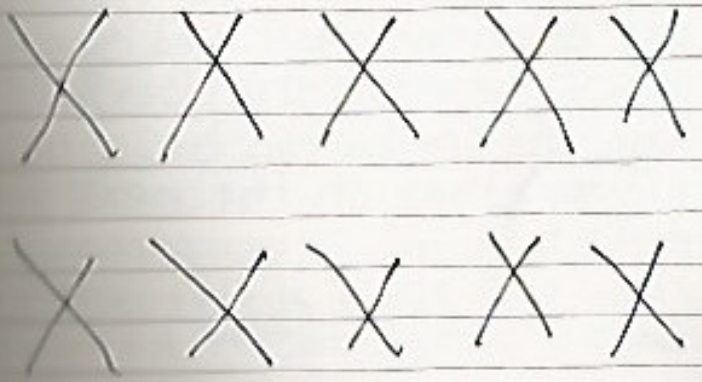
Green : Yellow
1 : 3

Date:

- This was because the green trait was hidden, with two possible alleles of (recessive) green peas. In the 2nd generation, green was in the genotype (allele), but yellow was both in the genotype and the phenotype (physical trait).

- This process is called Monohybrid inheritance. This can be defined as creating an offspring of one type in two contrasting genes.

(Turn Over)

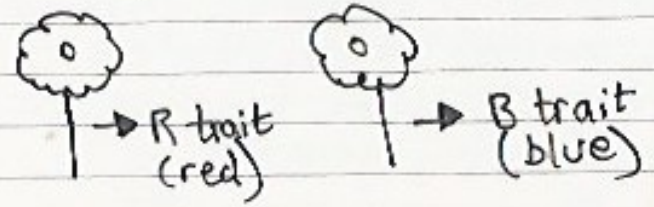


Date: - -

• Someone coding for the same allele (like YY) is homozygous, while Someone coding for different alleles is heterozygous.

• There are 3 types of dominance, Complete, Co-, and Incomplete types of Dominance.

• Example:



Note that they are both uppercase letters, so both are dominant, but Red is more dominant than Blue. The offspring can be illustrated as on the next page.

Date: - -

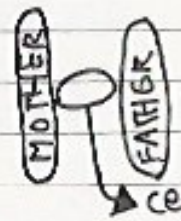
	Complete	Co	Incomplete
RR	Red	Red	Red
BB	Blue	Blue	Blue
RB	Red	Red+Blue	Purple

X

• There are 2 types of cell division: Mitosis (Asexual) and Meiosis (Sexual).

• Mitosis is a type of cell division (asexually) that results in two daughter cells being produced from a single parent cell. The daughter cells have the same number and kind of chromosomes as the parent nuclers. Mitosis occurs in most of our body cells (somatic cells). The exact copy of the DNA is made. The newly replaced chromosomes are called chromatids. They are joined by centromeres.

Date: - -



(1 from each parent)

. When the number of cells increases, the organism begins to grow.

. There are 6 phases of Mitosis:

Interphase, Prophase, Metaphase, Anaphase, Telophase, Cytokinesis

REMEMBER ORDER BY:

IPMATC

Date: - -

① Interphase

# of chromosomes: 46 to 92 in humans

The centromere opens. Two identical copies of the chromosomes are made. These are called chromatids. The organelles of the cell are also duplicated during this time. The cell also increases in size at this time. The majority of the cell's life is spent during this time.

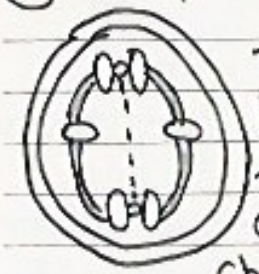
② Prophase

The DNA has already been duplicated by now. The chromosomes get condensed, and the nucleolus is removed.

Spindle fibers

Date: - -

③ Metaphase

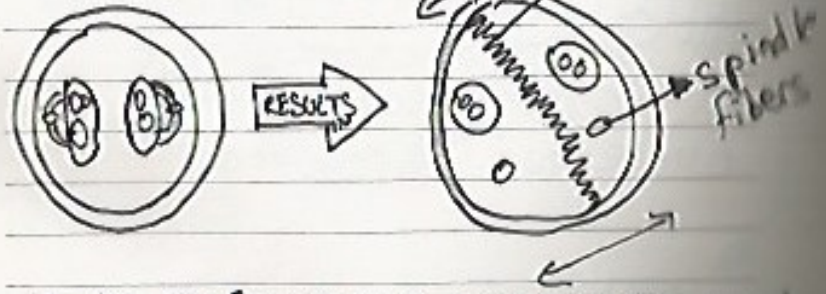


The Nuclear Membrane breaks off. The spindle fibers attach to the chromosomes. The chromosomes line up at the equator of the cell.

④ Anaphase

The spindle fibers shorten, centromere disappears, the chromosomes are pulled apart. The cell is ready for cell replication now.

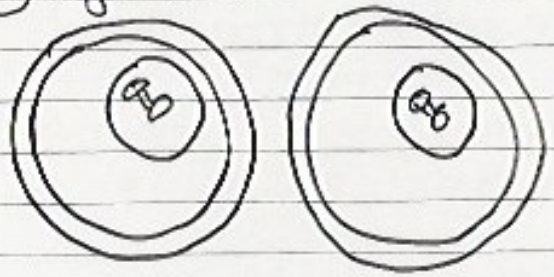
⑤ Telophase



Nuclear Membrane reappears. In oval shape, for now. Spindle fibers break apart.

Date: - -

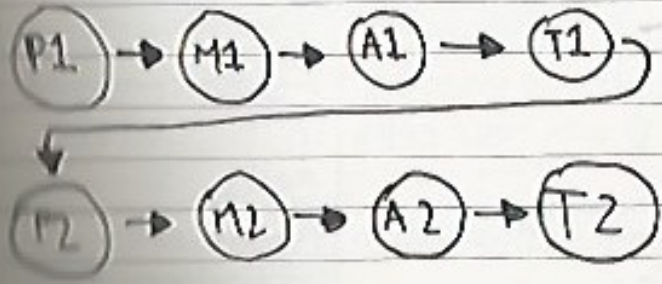
⑥ Cytokinesis



The cell splits into two daughter cells - same number of chromosomes.

CYCLE REPEATS

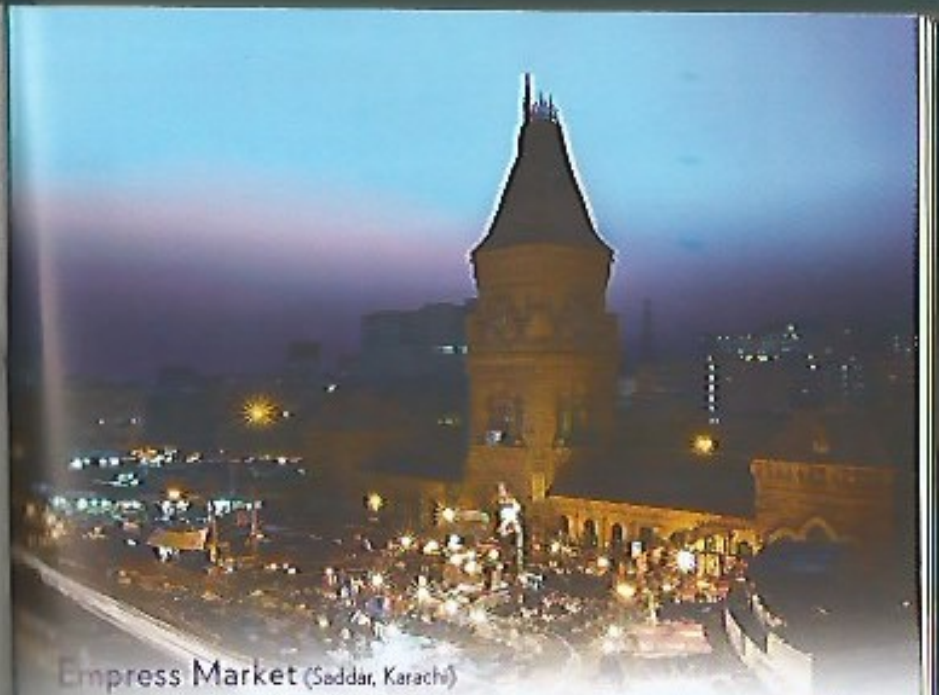
- Meiosis goes through similar phases. Meiosis only takes place in germ cells - gametes (sperm and egg cells).



Date: - -

- However, in Meiosis, the daughter cells are not identical. This is because in Prophase I, the two chromosomes "cross over", and the genes are mixed.

Mitosis	Meiosis
• Associated with Cytokinesis	Associated with Cytokinesis
• Asexual Reproduction	Sexual Reproduction
• Identical Daughter Cells	Not identical Daughter Cells
• Diploid cell	Haploid cell
• 2 cells produced in process of reproduction	4 cells produced in process of reproduction
• Produce somatic (normal body) cells	Produce germ cells &
• 46 chromosomes in Daughter cells	23 chromosomes in Daughter cells
• Chromose Duplication Prior	Chromosome Duplication Prior



Empress Market (Saddar, Karachi)

Empress Market is amongst the most popular and busiest for trade in Pakistan and reflects as one of the few historical spots of Karachi city. It is situated in the Saddar Town locality of Karachi and was built in 1884 during the British Raj era.

Date: - -

- Problems in Mitosis and Meiosis:

- In Mitosis, if the cell does not halve equally, the cell could have 45 or 47 chromosomes.

- In Meiosis, there could be errors in the dividing of sex cells.

- There are other types of Asexual Reproduction:
  - Sporulation
  - Parthenogenesis
  - Cloning
  - Binary/Multiple Fission
  - Budding
  - Vegetative Propagation
  - Fragmentation/Regeneration

X

Date:

- How the sperm moves:
  - Spermatogenesis in the testis
  - Maturation in the epididymis
  - Carried along vas deferens
  - Fructose for energy and protective mucus picked up at seminal vesicle
  - Prostate adds fluids to neutralise acid
  - Ejaculation through the penis.

Date: - EVOLUTION

- As known, all offspring have some traits different from their parents. This could be due to RANDOM DESCENT WITH MODIFICATION or ADAPTABILITY TO ENVIRONMENT.

- Darwin suggested that Natural Selection takes place, where organisms share traits to be able to survive in their respective habitats. For instance, insects could start changing colours to camouflage and not be seen by predators. This is evolution. Sometimes, this could happen due to external factors. For instance, fishers are constantly hunting bigger fish. Hence, smaller fish breed even smaller fish. This is evolution too. In addition, mammals changed and bore offspring that changed. It is suggested that the ancestors of whales and dolphins

Date: - -

were able to walk. Which brought in Darwin's theory, that all life comes from one common ancestor, which he took to be bacteria. He said that these bacteria could have been formed (not born) by molecular reactions. They could also have arrived by an asteroid that hit the Earth.

- Application of theory of Evolution: Why are grasslands turning into deserts?

↓

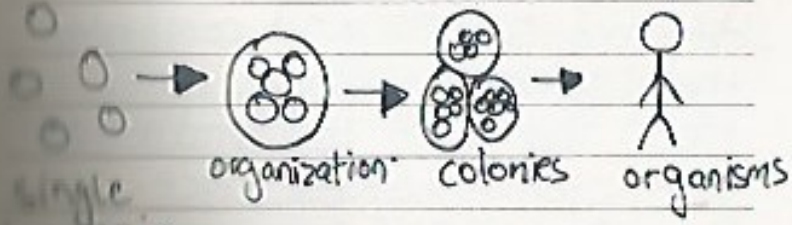
- When grass existed, wild animals dropped their dung and urine to allow the grass to thrive, tilled the grass with hooves, and ate excess grass. With their disappearance, grasslands started to die. Allan Savory, a biologist from Zimbabwe, found this to be true.

Date: - -

- How did bacteria come together to create organisms?

↓

- Scientists say that this is due to cooperation. Earlier, they say, bacteria operated individually. Over time, they came together, to form superorganisms. They specialized, and began to rely so much on each other that they could not disband. They divided and formed colonies and hence organisms.



X

X

Date: -

BIOTECHNOLOGY

·Biotechnology is the exploitation of biological processes for industrial and other purposes. It involves input from:

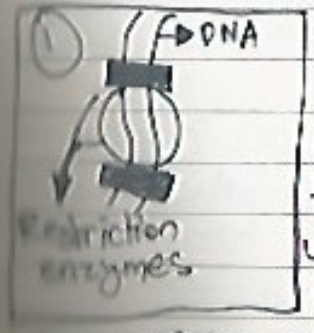
- Engineering
- Cell and Molecular Biology
- Computer Science
- Biochemistry
- Virology
- Genetics
- Microbiology
- Physiology
- Etc.

·Recombinant DNA Technology works by taking DNA from 2 different sources and combining that DNA into a single molecule. When that DNA is reproduced, DNA cloning takes place. Recombinant DNA is a molecule that combines DNA from 2 different sources. There are 6 steps of Recombinant DNA:

Date: - -

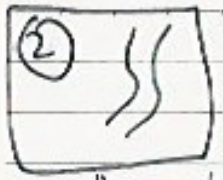
- Isolating
- Cutting
- Joining
- Transforming
- Cloning
- Selecting

·DNA cloning has been taken to many levels. For now, let's focus on E.Coli. DNA cloning is creating identical copies of a piece of DNA. This is the cloning of E.Coli:

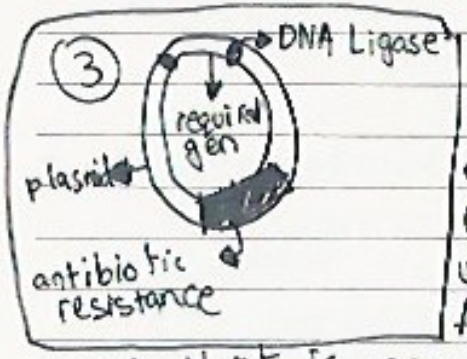


This is a strand of DNA. The circled area is a gene that needs to be cloned, so we want to "cut" it. Adding restriction enzymes cuts the gene at the right place.

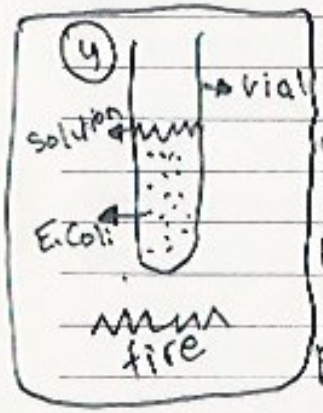
Date: - -



This is the desired gene. Once it has been cut, it has to be "pasted" somehow.

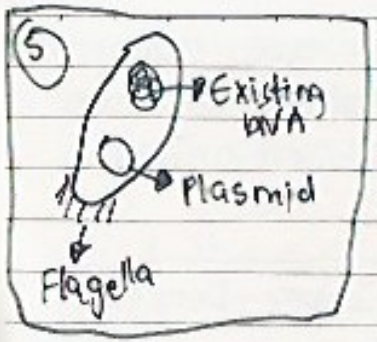


The required gene is pasted onto a plasmid (circular DNA) using DNA Ligase. Along with the gene that is required, another gene for antibiotic resistance is added to the plasmid. There is a reason for this.

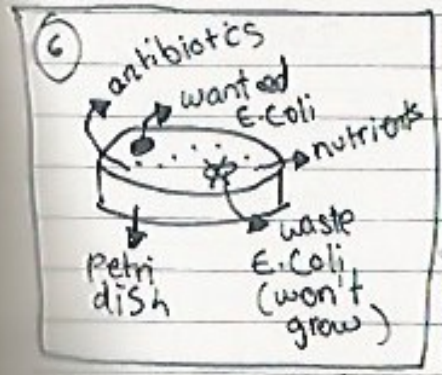


The plasmid is placed into a solution with E.Coli. A heat shock is provided to the E.coli, allowing some of it to take in the plasmid.

Date: - -



The bacteria will now look something like this.



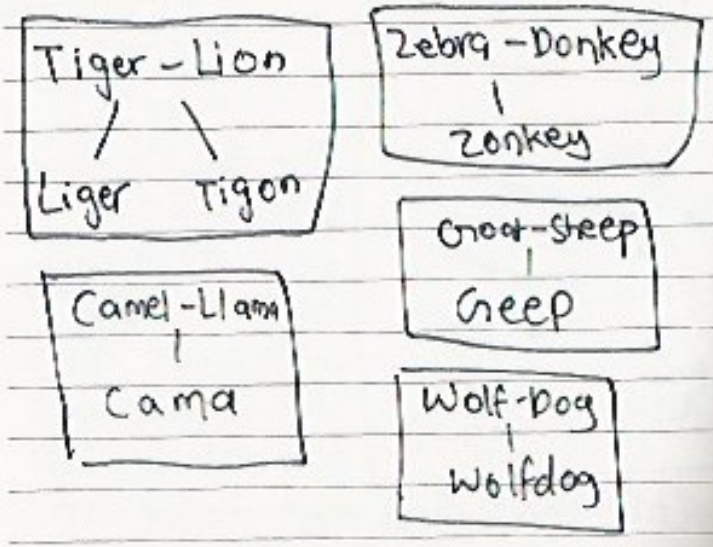
The E.Coli is placed on a petridish wil nutrients and antibiotics. The antibiotics are placed to kill E.coli that did not take up the plasmid. The desired E.coli will lives as it had had antibiotic resistance.

- This bacteria can be used for producing things like insulin

X

Date: - -

• Hybrid Animals are examples of animals created by two different species of animals.
Examples:



• Through Biotechnology, sequencing the human genome (all the genes + some extras that help create an organism). The first human genome was sequenced in 2003. It took 20 years to do so, and cost over 3 billion dollars.

Date: - -

• In sequencing a human genome, first, the genes are broken down into smaller pieces. Then, scientists use enzymes to make thousands of replicas of the same gene. To read this, scientists give a distinct colour to each letter that shows a base (A, C, T, G). A mixture of these coloured letters and enzymes is then added to the genome trying to be read. On each of the genome, stop, one of the coloured letters binds to its opposite (A-T and C-G). Scientists take pictures of these colours. Seeing the order of the colours allows to read the sequence. Computer programs "stich" together the millions of letters. Scientists are still working on how to decipher this information. The sum

Date: - -

of these genes determines our characteristics.

X

- Another of the feats of Biotechnology is 3D Organ Printing. 3D organ Printing is the use of a 3D printer to "print" living organs.

- First, a scan of the patient is made, detecting how the organ needs to look. This is made by a rotating scanner.

- Then, a sample of cells is used to make a "living ink". This is slowly poured down, and using a computer program, and a 3D printer, the organ is shaped. It is then placed in the incubator, which provides a similar environment to that of the human body.

X

X

Date: - -

BLOOD GROUP CHART (can take from)

Group	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	✓							
A-	✓	✓						
B+	✓		✓					
B-	✓	✓	✓	✓				
AB+	✓	✓	✓	✓	✓			
AB-	✓	✓	✓	✓		✓		
O+	✓		✓				✓	
O-	✓	✓	✓	✓				✓

X

X