**TOPIC 1: PLANT RESPONSES**

**What is irritability/sensitivity?**

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| It is the ability to detect changes and respond to them appropriately in plants. |

**Major groups of plant responses to stimuli.**

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| * **nastic response-** It is the movement exhibited by parts of plant in response in response to non-directional external stimulus. * **Tropic response-** It refers to growth movements by plants in response to light, gravity, chemical, contact and water stimuli. |

**TROPISM**

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| Tropism is defined in the following ways:   * It is a growth response towards or away from stimulus coming from one direction. * It is a growth toward or away from a stimulus. * It is a directional plant response which causes part of a plant to growth either towards or away from the stimulus.   Tropism can be positive or negative. Tropism is said to be **positive** if the response is towards the stimulus and it is said to be **negative** if the response is away from the stimulus.  Some examples of tropism include     1. **Gravitotropism** - growth response towards gravity. 2. **Phototropism** - growth response towards the force of light. It is also defined as a plant growth movement or bending of a plant part in response to unilateral stimulation by light. 3. **Thigmotropism-** growth response towards contact. 4. **Hydrotropism-** growth response towards the force of moisture |

**How does tropism occur?**

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| Tropism is growth toward or away from a stimulus. It is influenced by stimuli which include light, water, gravity and touch. |

**AUXINS**

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| Auxins are the plant growth hormones that cause plants to elongate and grow cells faster on the side of the plant farthest from the light.  Auxins are primarily produced in the tips of the plants. |

**PHOTOTROPISM**

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| Phototropism is the growth of a plant towards a light stimulus. In other words, phototropism is a directional response that allows plants to grow towards or in some cases away from a source of light.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\intoduction-image.jpg  **Example**  Seedlings of plants grow straight in dark environments in order to reach the sunlight above the ground. Once they break through the surface, they start bending toward the light because the growth of cells on the dark side is faster than the cells on the light side. However, if the amount of light is the same on all sides of the plant, then it will continue to grow straight upward instead of bending.  In **phototropism**, a plant bends or grows directly in response towards light. Shoots usually move towards the light; roots usually move away from it.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\auxinlight1.gif  **Positive phototropism** relates to plant growth towards a light source causing the leaves of the plants to be pointing towards the light source and includes most plant parts such as leaves and stems. This allows the leaves to absorb more light which maximizes photosynthesis. Shoots or above the ground parts of plants generally display positive phototropism, they bend toward the light. This response helps the green parts of the plant get closer to a source of light energy which can then be used for photosynthesis.  The diagram below shows shoot of plant growing towards a source of light:  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images (2).jpeg  **Negative** **phototropism** is plant growth away from light. Negative photo tropism is observed in roots. Roots, on the other hand, will tend to grow away from light.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\5a85135a65683.jpg |

**PHOTOTROPISM AND AUXIN**

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| Auxin is a plant hormone that controls and coordinates the growth of the tips of shots and roots.  Auxin acts by enabling the plant to external stimuli e.g.   1. The tips of shots to grow towards light- carbohydrates 2. The tips of shoots to grow upwards against gravity -geotropism, 3. The tips of root s grow to seek moisture in the soil.   **EFFECTS OF AUXINS ON GROWTH THE TIPS OF ROOTS & SHOOTS**  Auxin is produced in the tips of shoots and roots being soluble, it moves back by diffusion to stimulate cell growth- a process of cell enlargement and elongation. This process occurs in the cells immediately behind the tips of shoots and roots and change in growth direction is due to an equal distribution of auxin. If the tip is cut off, the shoot may stop growing because the auxin hormone is no longer available.  Auxin can promote growth in shoots but a high concentration of auxin can inhibit growth in the root to ensure it grows in the right direction.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\tropism_med.jpeg  The responses of plants roots and shoots to light, gravity and moisture are the result of unequal distribution of hormones like auxin, causing unequal growth rates and changes in growth direction.  When coleoptiles are exposed to a source of light, phototropism molecules on the illuminated side absorb lots of light, while molecules on the shady side absorb much less. Through mechanisms that are still not well understood, these different levels of phototropism activitation cause a plant hormone called auxin to be transported unequally down the two sides of the coleoptiles  More auxin is transported down the shady side, and les auxin promotes cell elongation, causing the plant to grow more on the shady side and bend in the direction of the light source.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\phototropism1-1024x770.png |

**HOW THE PLANT GROWTH HORMONE AUXINS WORK**

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| Shoots are positively phototropic- they grow towards light.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\tropisms-25-638.jpg  When light shines on a shoot, more auxin concentrates on the side that is in the shade or less light side- unequal distribution of auxin**.** This stimulates growth to elongate the cells more on the shaded side so the shoot bends upwards towards the light. In bending towards the light the shoot can absorb more light for photosynthesis and hence plant growth.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\plant04b.gif |

**AUXINS AND PHOTOTROPISM**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\854353d04d0453bd7bb2b0aa29953ac953ea2d70.png**  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\tropisms-24-638.jpg** |

**AUXINS AND PHOTOTROPISM**

**Explain what phototropism is and why plants might benefit from phototropism**

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| Phototropism is a growth response to a light stimulus.  **POSITIVE PHOTOTROPISM**  Positive phototropism causes the stems of plants to grow towards a light source causing the leaves of the plants to be pointing towards the light source. This allows the leaves to absorb more light which maximizes photosynthesis.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\auxin_phototropism-5a96b7553418c600366c97ea.jpg  **NEGATIVE PHOTOTROPISM**  Roots are negatively phototropic-grow away from light. Roots grow away from light if exposed to it on the surface of soil, so roots are negatively phototropic**.**  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\11.2.jpg**  If roots are exposed to light on or near the soil surface more auxin concentrates on the more shaded underside of the root. In the root, this high concentration of auxin inhibits growth on the underside i.e. cell elongation. This allows the greater elongation to occur on the upper side that is more exposed to the light. Consequently, the upper greater cell elongation makes the root bend and grow downwards deeper into the soil.  All the roots deep in the ground tend to grow downwards due to positive gravitropism . However, they will also grow towards a more concentrated area of water due to hydrotropism. By growing downwards, the roots can better access the soil for minerals and water. |

**THE IMPORTANCE OF PHOTOTROPISM TO PLANTS**

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| 1. Phototropism ensures that plant shoots grow towards source of light. This enables the plant to obtain light which is necessary for the process of photosynthesis. 2. In climbing plants, negative phototropism helps plants to identify objects and climb onto them thereby obtaining support. |

**PHOTOPERIODISM**

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| Photoperiodism is the regulation of development in response to day length. It allows some plants species to flower -switch to reproductive mode-only at certain times of the year. Positive phototropism causes the -stems of plants to growth towards a light source causing the leaves of the plant to be pointing. This allows |

**AUXINS AND GEOTROPISM**

**POSITIVE GEOTROPISM AND NEGATIVE GEOTROPISM**

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| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\1.14.7 Example of positive and negative tropism.jpg  **NEGATIVE GEOTROPISM**  Shoots are negatively gravitropic-they grow against the down force of gravity as shown above, the shoot grows upwards away from the force of gravity. If a shot starts to grow sideways- at an angle or horizontally, gravity causes more auxin to concentrate on the lower side-unequal distribution of auxin. Therefore, the lower side cells are stimulated to grow faster causing the shoot to grow and bend upwards. By growing upwards the shoots can better access the light for photosynthesis.  **POSITIVE GEOTROPISM**  Roots are positively geotropic - they grow towards the force of gravity. If a root is tending to grow sideways -horizontally, then due to gravity it tends to have more auxin on its lower side cells, causing the root to bend round downwards and become more firmlyembedded in the soil. By growingdownwards, the roots can better access the soil for minerals and water.  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\gNHZCyZ.png** |

**IMPORTANCE OF GEOTROPISM**

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| 1. Geotropism enables roots to grow downwards into the soil. In this way, roots are able to absorb water and mineral salts for the synthesis of their food. 2. Geotropism enables plants to anchor well into the soil hence ensuring that the plant remains firm against possible physical destruction such as wind and run-off water. 3. Geotropism also enables the shoot to grow upwards and as such, leaves are in a position to get light that plants require to carry out the process of photosynthesis. |

**AUXINS AND HYDROTROPISM**

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| Hydrotropism is the plant growth response towards moisture or water.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\biology.png C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images (3).jpeg  **POSITIVE HYDROTROPISM**  Roots grow towards moisture hence they are positively hydrotropic. If a root is exposed to an uneven distribution of moisture one side of the root is moister than the other, more auxin concentrates on the side with the most moisture-unequal distribution of auxin. Consequently the increased auxin level inhibits growth on the moisture side and stimulates a greater growth rate on the least moist side to make the root bend towards the moisture. By growing towards moisture, the roots can better access the soil for water and mineral salts too.  **NEGATIVE HYDROTROPISM**  Shoots grow away from moisture and are negatively hydrotropic. |

**Design an experiment to demonstrate hydrotropism**

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| Hydrotropism is the process of growth or movement of roots towards the source of water.  Here is an experiment that is performed to observe the growth of plants when water is present  **Procedure**   1. Take two beakers 1 and 2 2. In beaker 1 add moist soil in one part and sow the seeds. 3. In beaker 2 add dry soil in one part and moist soil in another part and sow the seeds. Also place a small beaker of water just adjacent to it. 4. Keep it for some time so that the plants can grow.   C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\1176611_1267195_ans_3d360ec48b384056b2355f576a9176c8.jpg  **Results**  It was found that in beaker 1 due to the presence of moist soil, plants will grow normally and roots will be straight.  In beaker 12 it was observed that the presence of water beaker next to its plant grows towards the water as shown in the figure above.  Conclusion  This experiment states that the plants move and grows towards the source of water hence plants show hydrotropism. |

**IMPORTANCE OF HYDROTROPISM**

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| It enables plant roots to obtain water and minerals which are necessary for plant growth. |

**AUXINS AND THIGMOTROPISM**

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| Thigmotropsim is the directional plant growth response to touch. This basically means that a plant alters its normal pattern or direction of growth or movement as the result of an external touch stimulus.  When a plant grows towards the stimulus of touch, it is said to exhibit positive thigmotropism. Conversely, when a plant grows away from the stimuli, it exhibits negative thigmotropism  **POSITIVE THIGMOTROPISM**  This type of thigmotropsim is exhibited by parts of the plant like the tendrils. Tendrils are specialized leaves, stems or petioles of plants. They are used for support in climbing plants. They tend to coil around the object which acts as the touch stimulus thus climbing on the object/stick.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images (7).jpeg  When growing, one side of the tendril touches the object. This signal is transmitted to the side that isn’t in contact with the stick and curling occurs. The rate of growth on the non-contact side increase, while the rate slows down on the side that is in contact with the stick. This is called differential growth. It leads to elongation of the of the non-contact side which eventually leads to curling of the tendril.  **NEGATIVE THIGMOTROPISM**  When a plant or a part of it, grows away from the touch stimulus, it is called negative thigmotropism. This is shown by the roots of plants. While growing, if the roots touch something, they change their direction and grow away from the touch stimulus. This helps them to navigate under the soil and grow into areas of least resistance.  Negative thigmotropism in roots is sometimes strong to trump other factors, like the pull of gravity. For example, in a vertical bean root, the stimulus of touch is enough to change the direction of growth of the vertical roots.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\Negative-thigmotropism.jpg |

**IMPORTANCE OF THIGMOTROPISM**

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| Herbaceous and other plants with weak stems are able to obtain support through thigmotropism. |

**ADVANTAGES OF TROPISM**

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| 1. Shoots growing towards light increase the rate of photosynthesis- more light can be absorbed by chlorophyll. 2. The root growing downwards can find minerals and water in the soil and be more firmly fixed in the soil too. |

**COMMERCIAL USE OF PLANT HORMONES**

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| 1. Plant hormones can be used to control the ripening of fruit or produce seedless fruits. 2. Use of tissue culture. Auxin hormones are added to the tissue growth medium as well as the nutrients any plant needs to grow. The hormone auxin stimulates cell division to form roots and shoots. 3. By adding a rooting powder to the compost containing a plant growth hormone like auxin, the growth of roots and subsequent shoots are greatly encouraged so new good quality plants grow more rapidly. 4. Some plant growth hormones can be used as selective weed killers to disrupt the growth of weeds but leave the crops unaffected. Selective weed killers have been developed from auxins which only affect broad-leaved plants. |

**CHEMOTROPISM**

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| Chemotropism is defined as the growth of organisms such as bacteria, plants and fungi navigated by chemical stimulus from outside of the organism or organism’s part.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images (10).jpeg ‘ |

**PRACTICAL USES /EFFECT OF AUXINS ON PLANT GROWTH**

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| 1. Auxins influence cell elongation. They do this by facilitating stretching of the cell as the cell gain water and stimulating formation of sap vacuoles. 2. Auxins stimulate the development of adventitious roots 3. Auxins induce parthenocarpy. Parthenorcarpy is the process whereby fruits are formed without fertilization. 4. Auxins prevent falling of fruits before reaching maturity 5. Auxins initiate secondary growth in plants by stimulating cell division in the cambium. 6. Synthetic auxins are used as herbicides or weed killers and as stimulants in rooting of cuttings. |

**TOPIC TWO- HUMAN RESPIRATORY SYSTEM**

The diagram shows the human respiratory system and functions of some of its parts.

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**Functions of the parts of the respiratory system**

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| 1. **Nasal cavity**   **Funtions**   * It filters the air * It moistens the air * It warms the air**.**  1. **Trachea**   The trachea is has rings of cartilage that provide the framework that keeps the trachea from collapsing.  **Functions**   1. **Air conduction**- It provides air passage to the lungs for respiration i.e. to inhale air rich in oxygen and exhale carbon dioxide. 2. **Protection-** The lining of the trachea has a sticky mucous lining that traps foreign substances. These trapped substances are expelled upwards and can either be excreted from the body as phlegm or swallowed in the oesophagus. 3. **Thermoregulation-** It warms and moistens the air**.** When the air is cold, the trachea helps to humidify and warm the air entering the lungs. When the air is hot, heat is carried away in exhaled air through evaporation of water.   The diagram below shows the lining of the trachea  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\c00010_f010-012a-9780702053252.jpg**   * The trachea is lined with columnar epithelium that secretes mucus which traps foreign particles such as dusts or germs. These particles are swallowed, coughed up or sneezed out. * It is lined with ciliated cells. Cilia sweep the mucus containing dust and germs upwards towards the back of the throat. The mucus is swallowed together with its trapped dust particles and bacteria. The bacteria are killed in the stomach by hydrochloric acid and enzymes.  1. **Bronchi and bronchioles**   Bronchi are the airways that lead from the trachea into the lungs and then branch into smaller bronchioles. They are the extensions of the wind pipe**.**  **Function**  The bronchioles carry oxygen rich air into the lungs and carry carbon dioxide rich air out of the lungs thereby aiding in the processes of breathing and respiration.   1. **Alveoli** C:\Users\new\Desktop\DOWNLOADS\gas.jpg   These are tiny air sacs in the lungs.  **Function**  They are used for gas exchange.   1. **Pleural membranes**     It is a double membrane that covers each lung. The pleural membrane produces pleural fluid that ensures the lungs remain air tight and allows friction free movement when breathing**.**   1. **Pleural fluid**   It is a fluid that is found between the layers of the pleural membranes of which line the cavity and surrounds the lungs.  **Functions**  It acts as a lubricant and hence allowsfriction free movement when breathing   1. **Diaphragm and its function**   The diaphragm is a thin skeletal muscle that sits at the base of the chest and separates the abdomen from the chest. It contracts and flattens when you inhale. This creates a vacuum effect that pulls air into the lungs. When you exhale, the diaphragm relaxes and the air is pushed out of the lungs. |

**MECHANISMS OF BREATHING IN HUMAN BEINGS**

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| The mechanisms of breathing involves two processes :inspiration (inhalation) and expiration (exhalation) as shown below    Inhalation and exhalation can also be shown by the following diagrams  **MECHANISM OF INHALATION (INSPIRATION)**  During inhalation, the external intercoastal muscles contract while internal intercoastal muscles relax, the ribs move upwards and outwards while the diaphragm muscles contract making it flatten. This increases the volume of the thoracic cavity leading to a reduction in air pressure inside the lungs. As a result air is forced into the lungs since the atmospheric pressure is being higher compared to the pressure inside the lungs.  **MECHANISM OF EXHALATION (EXPIRATION)**  During exhalation, the internal intercostal muscles contract while external intercostals mucles relax. The makes the ribs to move downwards and inwards while the diaphragm muscles relax making it become dome-shaped. This reduces the volume of the thoracic cavity leading to an increase in air pressure inside the lungs. Since the air pressure inside the lungs is higher compared to the atmospheric pressure, air is forced out of the lungs to the atmosphere. |

**LUNG MODEL**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\6.1.4f.jpg**  In the lung model, the bell is rigid hence it does move as compared to the chest cavity during breathing. |

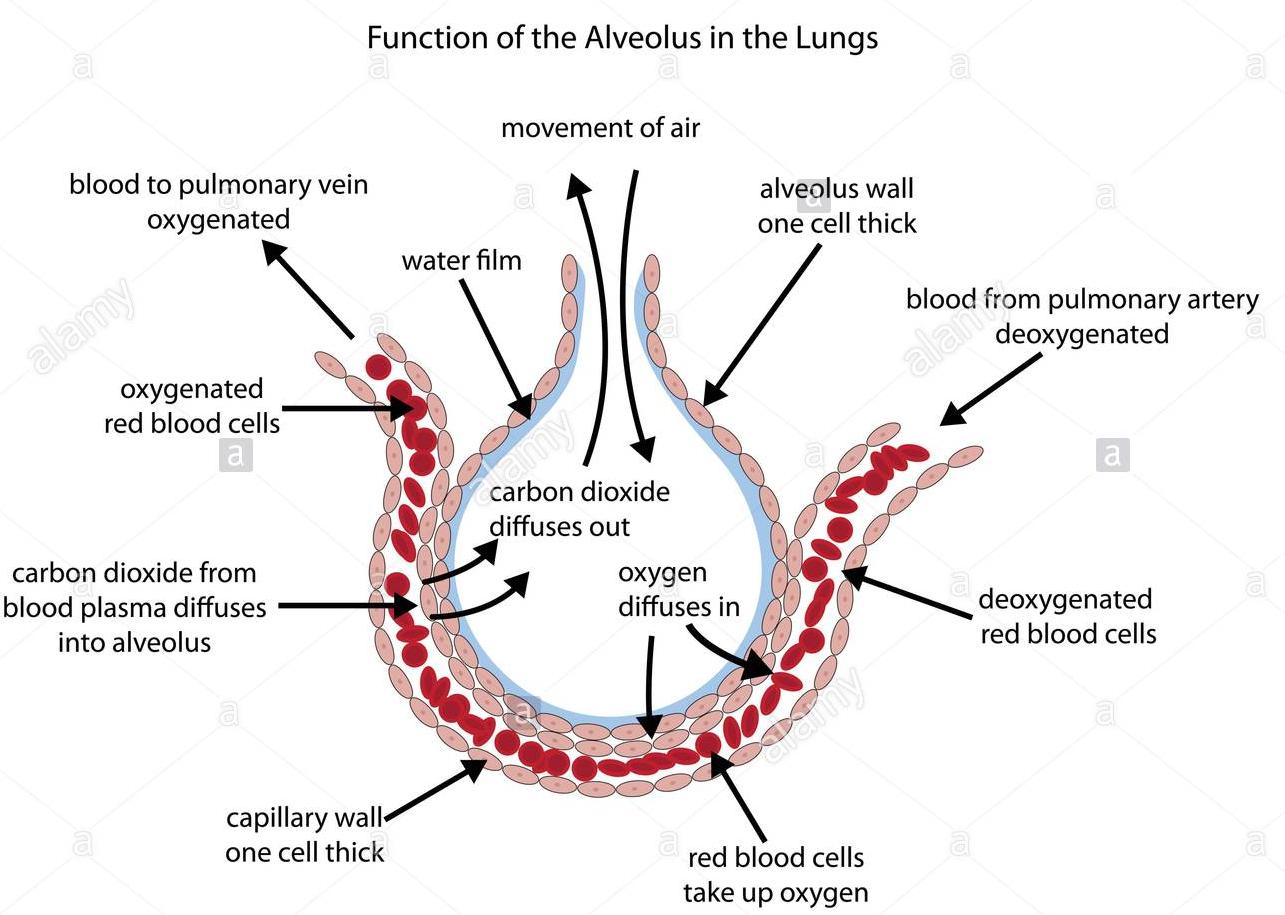
**FACTORS THAT INFLUENCE BREATHING RATE**

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| 1. **Carbon dioxide concentration in blood**   High amount of carbon dioxide in the blood leads to increased rate of breathing. The increased rate of breathing triggers an increase in the uptake of oxygen which results to an increase in the concentration of oxygen in the blood.   1. **Haemoglobin concentration or amount of red blood cells in the body.**   “If the level of red blood cells in blood is low, automatically the level of haemoglobin also goes down. When the concentration is low in the blood, less oxygen reaches the cells. The breathing rate increases in a bid to compensate the shortfall and meet the oxygen demand of the body.”  Haemoglobin in blood carries oxygen from the lungs to the rest of the body or the tissues. There it releases the oxygen to permit aerobic respiration to provide energy to power the functions of the organism in the process called **metabolism**. Haemoglobin combines with oxygen in the lungs to form oxyhaemoglobin and carries oxygen in the form **oxyhaemoglobin** to the body tissues. Haemoglobin also helps in the transportation of carbon dioxide and hydrogen ions back to the lungs.   1. **Atmospheric pressure and oxygen concentration**   The higher you go when you climb a mountain, atmospheric pressure decreases and the amount of oxygen decreases. Therefore less oxygen is available. Breathing rate increases in order to obtain more oxygen necessary for normal functioning of the body.   1. **State of the body i.e. whether the body is active or not/physical exercise-** When the body is undergoing physical exercise, energy is required for the contraction and relaxation of muscles. Therefore, more oxygen is required to burn glucose and produce additional energy required by the muscles. This leads to increase in the breathing rate. Breathing rate also increases to remove the increased levels of carbon dioxide in the blood which arise as a result of increased respiration. 2. **Emotional changes in the body**   When emotional changes in the body occur, the body requires more energy than normal hence increased rate of respiration. There is need for more oxygen and breathing rate is increased.   1. **Health status of the body**   Healthy people usually breathe normally. However, unhealthy people in most cases breathe much slower depending on the nature and extent of illness. |

**WHAT IS THE EFFECTS OF DOING EXERCISES ON EACH OF THE FOLLOWING?**

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| 1. **Rate of breathing**   Physical activity or doing an exercise increases the rate of breathing.   1. **Depth of breathing**   Vigorous and prolonged exercises the rate of breathing but also increases the depth of breathing.   1. **Carbon dioxide concentration**   During exercise, the rate of respiration increases to produce more energy. As a result, there is a higher accumulation of carbon dioxide in blood.   1. **Oxygen concentration**   As a result of exercises, there is an increase in the amount of oxygen used for respiration. This causes an increase in the rate of breathing. |

**REGULATION OF BREATHING MECHANISM IN HUMAN BEINGS**



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| The rate at which breathing takes place controlled by medulla oblongata. The process is determined by the concentration of carbon dioxide in blood. The carbon dioxide is carried in blood in form of weak carbonic acid. The medulla oblongata contains cells with chemoreceptors in the respiratory centre that detect the concentration of hydrogen ions in blood.  In case of high carbon dioxide concentration, the concentration of weak carbonic acid in blood increases leading to an increase in hydrogen ion concentration in blood.  **Explain how medulla oblongata regulates breathing?**  When blood with high hydrogen ion concentration passes through the medulla oblongata and is detected by chemoreceptors, nerve impulses are generated and sent from the respiratory centre to the diaphragm, intercostals muscles and ribcage. As the result, external intercostals muscles contract while internal intercostals muscles relax and the diaphragm flattens and the ribs move upwards and outwards thereby increasing the volume of the chest cavity. When the volume of the lungs increases, pressure inside the lungs reduces and air from the atmosphere rushes into the lungs.  Gaseous exchange occurs in the alveoli i.e. oxygen gets into the bloodstream while carbon dioxide diffuses into the alveolar space from the blood. This lowers the level of carbon dioxide in the blood and the pH returns to normal. |

**MEASURING AND CALCULATING BREATHING RATE**

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| Breathing rate refers to how fast or slow a person is breathing.  In other words, breathing rate is the number of times we breathe in and out per minute.  It is the number of breaths per minute. One complete breath is composed of one inhalation and one exhalation  One complete breath = Inhalation + exhalation  **Breathing rate**  **=** |

**LUNG CAPACITY**

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| Total lung capacity refers to 5 litres of air that an adult human has the capacity to hold.  It can also be defined as the maximum amount of air that can fill the lungs.  Total lung capacity = TV + IRV + ERV + RV where  Total lung capacity = VC + RV  VC = Vital Capacity  TV = Tidal Volume  IRV= Inspiratory Reserve Volume  RV = Residual Volume   1. **Tidal Volume-** It is the amount of air inspired during normal, relaxed breathing. It can also be defined as the amount of breathed in and out while one is at rest. 2. **Inspiratory Reserve Volume/Complementary air-** It is the additional air that can be forcibly inhaled after the inspiration of a normal tidal volume. In other words it is the additional air to tidal air that is taken into the lungs during deeper breathing. 3. **Expiratory reserve volume/Supplementary air-** It is the additional air that be forcibly exhaled after the expiration of a normal tidal volume. 4. **Vital capacity-** It is the total amount of air that can be expired after a full inhalation. It is approximately 80% of total lung capacity.   **Vital capacity = TV + IRV + ERV**  TV = Tidal Volume  IRV= Inspiratory Reserve Volume  ERV = **Expiratory reserve volume**   1. **Inspiratory Capacity- It is the maximum amount of air that can be inspired. It can be obtained using the following formula:**   IC = TV + IRV  IC = Inspiratory Capacity  TV = Tidal Volume  IRV = Inspiratory Reserve Volume   1. **Residual Volume-** It is the volume of air still remaining in the lungs after the expiratory reserve volume is exhaled.   Residual Volume = Lung capacity - Vital capacity   1. **Functional Residual Capacity -** It is the amount of air remaining in the lungs after a normal expiration.   It can be obtained using the following formula :  FRV = RV + ERV, where FRV = Functional Residual Capacity, RV = Residual Volume and ERV = Expiratory Resrve Volume  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\3-s2.0-B9781455728961000044-f004-010-9781455728961 (1).jpg |

**GAS EXCHANGE OR EXTERNAL RESPIRATION**

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| External respiration is the sequence of events that results in the exchange of oxygen and carbon dioxide between the atmosphere and the lungs. During external respiration, nerve impulses stimulate the breathing process or ventilation which move air through a series of passages into and out of the lungs. After this, there is an exchange of gases between the lungs and the blood. The blood transport s gases to and from the tissues cells as shown in the figure below  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\llustrates-that-gas-exchange-in-alveoli-is-a-complex-interaction-between-ventilation-of.png  Finally, the cells utilize the oxygen in the process called cellular respiration. |

**TISSUE RESPIRATION**

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| * Tissue respiration is the biochemical breakdown of assimilated food substances in the cells to release energy in the form of Adenosine Triphoshate (ATP) and heat. It occurs both in the cytoplasm and mitochondria. Energy produced during tissue respiration is used by the organism to carry out activities such as transport, uptake of nutrients, locomotion, growth, excretion and nerve impulse transmission. * Takes place within cells involved in metabolic reactions where  1. Oxygen is consumed 2. Carbon dioxide is given off 3. ATP is produced as energy |

**MITOCHONDRIA**

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| This is the place in the living cells where tissue respiration occurs. Mitochondria are adapted for their function because they are highly folded to increase the surface area on which the chemical reactions can take place.  Mitochondria contain enzymes that assist in the chemical reaction. These enzymes includeDecarboxylase, dehydrogenase and phosphofructkinase. |

**DIFFERENCES BETWEEN CEL RESPIRATION AND EXTERNAL RESPIRATION**

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| **Cell/tissue respiration** | **External/gaseous exchange** |
| Occurs in the cells | Occurs on the respiratory surface |
| It is a physical process | It is the chemical process |
| **It** concerns with burning of food to release energy | It involves processes that bring air into the lungs and finally oxygen into the cells. |

**GAS EXCHANGE IN THE LUNGS**

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| Gas exchange occurs in the lungs. The process begins by getting their into the lungs through the nose. Hair and mucus in the nose cleans the air to make it clean before gas exchange in the lungs. Once in the alveolar space , the air gets to interact with blood moving through the blood in the blood capillaries.  **The figure below shows how gas exchange occurs in the alveolus in the lungs.**    Pulmonary artery transport deoxygenated blood to the lungs. Hemoglobin combines with oxygen to form oxyhaemoglobin. The pulmonary artery transport oxygenated blood away from the lungs to the body tissues.    The sequence of events of gas exchange in the alveolus can also be clearly represented by the diagram below.  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\levi8_c001f001.png**  **Diffusion gradient of oxygen from the atmosphere into the lungs**  Diffusion gradient from the atmosphere into the lungs is maintained because oxygen is at a higher concentration in the air in the alveolar space than in the blood in the capillaries. This creates a diffusion gradient hence the oxygen can diffuse into the blood in the blood capillaries. Oxygen therefore first dissolves in the water layer in the alveolar lining, then diffuses across the alveolus and then the capillary walls into the red blood cells. The blood becomes oxygenated blood which is carried to the heart by the pulmonary vein. From the heart, the oxygenated blood is pumped to supply the oxygen to those tissues. See the movement of oxygen in the diagram above and below.  **Diffusion gradient of carbon dioxide from the tissue tissues to the atmosphere**  The diffusion gradient of carbon dioxide from body tissues to the atmosphere is maintained because there is high concentration of carbon dioxide in the body tissues than in the alveolar space. The carbon dioxide diffuses across the capillary wall and alveolus wall into the alveolar space and is eventually expelled during exhalation. See the movement of carbon dioxide in the figures above. |

**THE COMPOSITION OF INHALED AND EXHALED AIR**

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| **Gas** | **Inhaled air (%)** | **Exhaled air (%)** |
| Oxygen | 20.95 | 16.20 |
| Carbon dioxide | 0.04 | 4.00 |
| Nitrogen | 79.00 | 79.00 |
| Water vapour | variable | saturated |
| **In the above table:**   1. The percentage of oxygen in exhaled air is lower than in the inhaled air. The reason is that the body cells use oxygen for respiration. 2. The carbon dioxide content is greater in the expired air than inspired. This because the body cells produce carbon dioxide in respiration which diffuses from the blood into alveolar air. 3. The water vapour in the exhaled in the exhaled air is always high because the respiratory surfaces are always moist so some of the moisture evaporates and is lost as air is breathed out. 4. The nitrogen content of the two kinds of air is the same. This is because the body does not use it for anything, nor does the body makes any nitrogen so the rate of diffusion into and out of the blood is the same. | | |

**DIFFERENCES BETWEEN EXCHANGE OF GASES IN LUNGS & IN TISSUES**

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| **In lungs** | **In tissues** |
| Gas exchange is between the air and  the blood cells | Gaseous exchange is between  tissue fluid and tissue cells |
| Oxygen diffuses into the blood  cells while carbon dioxide diffuses  out into the air | Carbon dioxide diffuses into the blood cells while oxygen diffuses out into the tissue cells. |
| Gases must first dissolve in the  moist linings of capillary walls | Gases are already in solution form in the plasma |
| It is a rapid process and takes  the duration between breathing in  and out | There is plenty of time for exchange of gases to take place as the tissue  fluid bathes the cells. |
| **Similarities between exchange of gases in lungs and tissues** | |
| 1. In both, oxygen and carbon dioxide diffuse along their concentration gradients. 2. In both, haemoglobin found in red blood cells is the transport agent. | |

**CHARACTERISTICS OF ALVEOLUS FOR EFFICIENT GASEOUS EXCHANGE**

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| 1. Contains very thin epithelial cells- provides short distance of the diffusion of gases across them 2. Capillary walls consist of a single layer i.e. very thin - good for diffusion 3. Narrow capillary walls- this makes red blood cells flow quite slowly in it. It provides ample time for contact and diffusion. 4. The capillary wall lies next to the wall of the alveolus- This provides very short distance for diffusion of gases across it. 5. Presence of dense network of blood capillaries around alveoli- These facilitate the transportation of gases. 6. Water film of moisture in alveoli lining- This dissolves oxygen for easy absorption to occur. 7. Numerous number of alveoli in the lungs- This increases surface area for absorption. |

**IMPORTANCE OF GASEOUS EXCHANGE IN LUNGS AND TISSUES OF ORGANISMS**

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| Gas exchange is important because   * Exchange of respiratory gases in animals. * Exchange of photosynthetic gases in plants * Organisms are able to obtain useful gases from their environment. * Organisms are able to get rid of waste gases into their environment |

**TYPES OF TISSUE (CELLULAR) RESPIRATION**

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| 1. **AEROBIC RESPIRATION**   This is the breakdown of glucose in the presence of oxygen to release energy in the form of ATP (adenosine Triphosphate0, carbon dioxide and water.  The following is the word equation of aerobic respiration:  **Glucose** **+ water carbon dioxide + water vapour + Energy**  The following is the balanced chemical equation of aerobic respiration:  **6O + + Energy**  In the above equations glucose is broken down by oxygen to release energy with carbon dioxide and water vapour being produced as byproducts of the reaction.  Aerobic respiration occurs in the mitochondria of the living cells. It occurs both in plants and animals.   1. **ANAEROBIC RESPIRATION**   This is the breakdown of glucose to release energy in the absence of oxygen and producing lactic acid as by product in the muscles of animals or producing Ethanol and carbon dioxide as by-products in plants.  **Anaerobic respiration in the muscles of animals**  It occurs when a person carries out vigorous exercise; the lungs and heart are not able to get sufficient oxygen to the muscles in order for them to respire. The word equation of anaerobic respiration in the muscles of animals is :  **Glucose Lactic acid + energy**  The balanced chemical equation of aerobic respiration in the muscles of animals is”  **2ATP + Heat**  When a person does heavy exercise, the body does not provide the muscles with enough oxygen, so the muscles begin to use anaerobic respiration. This creates a buildup of lactic acid which gets painful. When he/she stops exercise, he/she has an oxygen debt. The oxygen breaks up the lactic acid. After heavy exercise a person breathes heavily for a while because when the brain detects high levels of carbon dioxide and the lactic acid in the blood, the pulse and breathing rate are automatically increased to try and rectify the situation.  **Anaerobic respiration in plants**  In plants, glucose is broken down to produce energy, alcohol and carbon dioxide.  Below is the word equation and chemical equation for anaerobic respiration in plants:  Word equation of anaerobic respiration in plants (Fermentation)  Glucose Ethanol + carbon dioxide + Energy  Chemical equation of anaerobic respiration(Fermentation)  **2C2H5OH +2CO2 + Energy**  When the above reaction occurs in yeast cells it is referred to as fermentation. Fermentation is the process used for baking bread and brewing alcohol. |

**CHARACTERISTICS OF ALCOHOLIC FERMENTATION**

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| * It takes place only in cytoplasm * It produces little energy * Ethanol produced still stores energy |

**ADVANTAGES OF ANAEROBIC RESPIRATION**

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| * Helps plants survive periods of floods * Helps roots survive waterlogged conditions * Helps germinating seeds to survive * Industrial production of alcohol, bread , yeast, yoghurt, chambiko and other milk products |

**DISADVANTAGES OF ANAEROBIC RESPIRATION**

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| Lactic acid is toxic when it accumulates in animal cells. It results in muscles tire or fatigue.  Indicators   * Oxygen debt - more oxygen is needed to break further the lactic acid into water and carbon dioxide. * Panting breath after strenuous exercise. |

**ABNORMAL CONDITIONS ASSOCIATED WITH RESPIRATORY SYSTEM**

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| The following are the common diseases that affect respiratory tract   1. **The common cold and flu**- The virus attack and destroy cells of mucus membrane.   Signs of the common cold and flu may include runny nose, sneezing, coughing, sore throat and fever.   1. **Tuberculosis (TB) -** The bacterium attack the lungs and various parts of the body.   Signs of TB include dry cough persistent for over three weeks.   1. **Pleurisy-** Bacterial infection of the pleural membrane. They are roughened. Signs include severe pain during breathing 2. **Lung cancer-** occurs when cells in the alveoli start to divide too rapidly producing -turmour reducing its capacity to exchange gas efficiently. 3. **Bronchitis**- Inflammation of the bronchial tubes due to accumulation of mucus in the lungs as a result cilia destruction by smoking.   **Signs** - Bad coughs   1. **Asthma-** Restriction of airflow into the bronchi and bronchioles due inflammation of the two.   **Signs-** wheezing, difficulty in breathing, feeling tightness in the chest.   1. **Whooping cough-** An infection of the respiratory tract by bacteria.   **Signs-** Whoop when coughing |

**CARBON MONOXIDE POISONING**

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| * Carbon monoxide is formed when incomplete combustion occurs. Incomplete combustion occurs when burning fuel where there is insufficient oxygen supply. * Carbon monoxide poisoning can occur because haemoglobin takes carbon monoxide much more readily than oxygen in the blood to form a fairly stable compound called carboxyhaemoglobin. * The formation of carboxyhaemoglobin reduces the oxygen-carrying capacity of the blood causing death. People die due to suffocation when they sleep in a room which has all the windows and doors closed and in which fuel is burning. Carbon monoxide causes suffocation which results to death. * Death will occur because  1. Lack of oxygen results to less energy 2. Body process stops due to lack of energy. 3. Suffocation will take place.  * Signs of carbon monoxide poisoning  1. The person develops severe headache. 2. The person has nausea 3. Abdominal pains sometimes 4. The person feels dizzy 5. The person has a dry cough.  * First aid for carbon monoxide poisoning  1. Allow the patient to get plenty of fresh air. 2. If the person is not breathing, try artificial respiration like mouth to mouth. 3. Loosen all tight clothing to allow free circulation of blood. 4. In gas or fumes breathe as little as you can to avoid taking in contaminated air.  * Preventing carbon monoxide poisoning  1. Burn gas, charcoal etc at a well ventilated place. 2. Allow charcoal to burn to red before it is taken into the house. 3. Make sure that the charcoal stove is removed from the room before sleeping. |

**DROWNING**

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| The lungs of the victim are filled with water breathing may stop. It is necessary that breathing must be restored by artificial respiration within three minutes. |

**SMOKING**

**The following are the ingredients of cigarette smoke and their hazards**

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| **Substance** | **Hazards** |
| Tar | 1. Damages cilia 2. It thicken the inner lining of respiratory tract causing cancer 3. It irritates the inner of respiratory tract causing inflammation that result into bronchitis. |
| Nicotine | 1. Constricts blood vessels thereby raising Blood Pressure. 2. Increases the level cholesterol in blood thereby increasing chances of heart attack. 3. It is addictive it become very difficult to stop smoking. |
| Carbon monoxide | 1. Causes suffocation. |

**DANGERS OF SMOKING DURING PREGNANCY**

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| Pregnant women who smoke produce smaller and under developed babies because   1. Nicotine constricts placental blood vessels thereby reducing the flow of food and nutrients to the baby. 2. Nicotine increases the heartbeat of the embryo. 3. Carbon monoxide reduces amount of oxygen in the mother’s blood as such the baby get little oxygen. |

**TOPIC THREE- EXCREATARY SYSTEM**

**Define the term excretion.**

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| Excretion is the process by which organisms remove waste products of metabolism from their bodies.  In other words, excretion is a process by which metabolic waste is eliminated from an organism. |

**EXAMPLES OF METABOLIC WASTES PRODUCED IN THE CELLS OF ORGANISMS**

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| Metabolic waste is the left over products of both catabolism and anabolism. Examples of metabolic wastes excess water, carbon dioxide, bile pigments, toxins, dead cells, urea, uric acid etc |

**THE HUMAN URINARY SYSTEM**

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| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\illustration-of-the-anatomy-of-the-urinary-system-front-view-125801.gif  **C:\Users\new\Desktop\CHIVANGA\cbse_class_10_imp_bio_diagram5.jpg** |

**THE STRUCTURE OF THE HUMAN URINARY SYSTEM**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\73758890-human-urinary-system-labelled-diagram.jpg**  **Functions of the different parts of the human urinary system**   1. **Inferior vena cava**- It carries deoxygenated blood from the lower half of the body to the right atrium of the heart. See the inferior vena cava below as shown by the human heart. 2. **Dorsal aorta**- It carries oxygenated blood away from the heart to the rest of the body. see the heart above. 3. **Renal artery-** It carries oxygenated blood from the heart to the kidneys for nutrition and cellular respiration. 4. **Renal arteries-** They carry deoxygenated blood after waste products have been removed via glomerular filtration back from the kidneys to the heart. 5. **Ureter-**It carries urine from the kidneys to the urinary bladder**.** 6. **Urinary bladder-** It stores urine 7. **Sphincter muscles**- They help to keep urine from leaking by closing tightly like a rubber band aroundthe opening of the bladder. 8. **Urethra**- It allows urine to pass outside the body. |

**SECTION THROUGH A KIDNEY**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{000011E8-0001-0001-0000-000000000000}\766803957338c852b1e794cabccbfadf.jpg**  **Cortex**  This is the place where ultra-filtration process occurs in the kidney. It contains Bowman’s capsule that contains glomerulus where filtration takes place.  **Medulla**  This is region in the human kidney where reabsorption process of useful substances takes place.  **Renal artery**  It carries oxygenated blood from the heart to the kidneys for nutrition and cellular respiration.  **Renal arteries**  They carry deoxygenated blood after waste products have been removed via glomerular filtration back from the kidneys to the heart.  **Renal pelvis**  This collects urine after formation and transports it to the ureter.  **Ureter**  It carries urine from the kidneys to the urinary bladder**.**  **C:\Users\new\Desktop\DOWNLOADS\Kidney_1_330x315.png** |

**FORMATION OF URINE IN THE KIDNEY**

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| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\29199612842_10a6f0fea4_o.png   1. **Glomerular filtration**   Inside the glomerulus, blood pressure pushes fluid from capillaries into the glomerular space through filtration membrane which allows water and small solutes to pass (the Glomerulus filters water and other substances from the blood stream) Blood proteins and blood cells (red blood cells, white blood cells and platelets) because of the large molecular size are not filtered. The proteins and blood cells remain in the blood and continue to flow to the efferent arteriole   1. **Tubular reabsorption**   When the glomerular filtrate exits the glomerulus, it flows into a renal tubule in the nephron. Flows continues through the renal tubules including the **proximal tubule**, the **Loop of Henle**, through the **distal tubule** and finally leaves the kidney by means of the **collecting duct**, leading to the **pelvis**, the dilated portion of the **ureter**. As it moves, the needed substances and some water are reabsorbed through the tube wall into adjacent capillaries.   1. **Tubular secretion**   The filtrate absorbed in the glomerulus flows through the renal tubule where nutrients and water are reabsorbed into blood capillaries. At the same time, waste ions and hydrogen ions pass from the capillaries into the renal tubule. This process is called **secretion.** The secreted ions combine with the remaining filtrate and become urine. The urine flows out of the nephron tubule into a collecting duct. It passes out of the kidney through the renal pelvis into the ureter and down to the bladder  **THE FORMATION OF URINE IN THE KIDNEY**  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\Physiology_of_Nephron.png  Urine is formed in the nephron which consist of the following parts  There are three main steps of urine formation: **glomerular filtration**, **reabsorption** and **secretion**. These processes ensure that only waste and excess water are removed from the body.   1. **Ultra filtration**   Ultra filtration is processes occur in the Bowman’s capsule that found in **the cortex** producing glomerular filtrate. Ultra filtration occurs in the Bowman’s capsule due to high blood pressure in the glomerulus. Glomeruls is a network of capillaries surrounded by Bowman’s capsule. The high blood pressure occurs/develops in the glomerulus because of the following three reasons:   1. The afferent arteriole is wider than efferent arteriole thereby creating pressure. See the afferent arteriole and efferent arteriole in the diagram below   C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\Screenshot 2019-07-16 at 2.33.23 PM.png  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\image8.jpg   1. The glomerulus has narrow lumen thereby creating resistance. 2. Blood flowing to the kidney comes from the renal artery which branches from aorta whose blood is at high pressure. 3. **The filtration membrane keeps Blood cells and large proteins in the blood stream**   Inside the glomerulus, blood pressure pushes fluid from capillaries into the glomerular space through filtration membrane which allows water and small solutes to pass (the Glomerulus filters water and other substances from the blood stream)  Blood proteins and blood cells (red blood cells, white blood cells and platelets) because of the large molecular size are not filtered. The proteins and blood cells remain in the blood and continue to flow to the efferent arteriole. This means that only **blood cells** and **large proteins** remains in the glomerulus and do not appear in the filtrate or urine and pass to the efferent arteriole after filtration in the glomerulus while the rest pass out of the glomerulus to form **glomerular filtrate**. This means the high blood pressure squeezes the blood against the walls of the capillaries of glomerulus which are semi-permeable so that small molecules are filtered out by the pressure into the renal tubule via proximal tubule. This process is called **ultra filtration.** The glomerular filtrate (fluid) passes through the glomerular membrane and flows from the glomerular capsule further into the nephron.  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\main-qimg-76706dad9051e3d365c53850e871b533-c.jpeg**  Blood enters the kidneys through the renal arteries. Each nephron contains glomerulus that has a network of tiny blood capillaries that filter the blood. The glomerulus are tiny and numerous hence adapted for their function.   1. **Reabsorption moves nutrients and water back into the blood stream (occurs in the medulla)**   The glomerulus filters water and small solutes out of the blood. The resulting **glomerular filtrate** contains waste such as urea, but also other substances the needs such as essential ions, glucose, amino acids, and mineral salts.  When the glomerular filtrate exits the glomerulus, it flows into a renal tubule in the nephron. Flows continues through the renal tubules including the **proximal tubule**, the **Loop of Henle**, through the **distal tubule** and finally leaves the kidney by means of the **collecting duct**, leading to the **pelvis**, the dilated portion of the **ureter**. As it moves, the needed substances and some water are reabsorbed through the tube wall into adjacent capillaries.  Process involved in reabsorption in the medulla of the kidney are   1. **Osmosis**   In the kidney, the loop of Henle is the portion of nephron that leads from the proximal convoluted tubule to the distal convoluted tubule. The loop of Henle’s main function is to create a concentrated gradient in the medulla of the kidney, near the collecting duct which is the difference in concentration. This process reabsorbs water by osmosis and creates concentrated urine for excretion.  **Osmosis** is the net movement of water from the region of low solute concentration to the region of high solution concentration across semi-permeable membrane.   1. **Diffusion**   In order to get water to leave the filtrate through diffusion, the area surrounding the nephron must have a high salt concentration. A high salt concentration in the fluid outside of the nephron will provide a driving force for osmosis allowing water to be recovered from the filtrate.   1. **Active transport**- **active transport in the kidney**   Active transport uses energy to pump or transport substances across the membrane. Active transport is used against the concentration gradient of solutes which means when low concentration move to high concentrations instead of the other way around. Active transport can be seen in the kidneys at the reabsorption stage in the nephron. Along the nephron, a large network of capillaries surrounds the tubules that carry the waste. Substances that the body needs from the waste that can be reused are reabsorbed into the blood stream. These substances are usually glucose, amino acids, vitamins, water and more. This reabsorption usually happens in the proximal and distal convoluted tubules and the loop of Henle.  NB: Concentration gradient is difference between two regions where there high concentration of solutes and where there is low concentration of solutes.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\in-the-formation-of-urine.jpeg   1. **Waste ions and hydrogen ions secreted from the blood complete the formation of urine.**   The filtrate absorbed in the glomerulus flows through the renal tubule where nutrients and water are reabsorbed into blood capillaries. At the same time, waste ions and hydrogen ions pass from the capillaries into the renal tubule. This process is called **secretion.** The secreted ions combine with the remaining filtrate and become urine. The urine flows out of the nephron tubule into a collecting duct. It passes out of the kidney through the renal pelvis into the ureter and down to the bladder.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\nQHiYjYXST6c2zFIaNU8_b0710aaaec469f7f0cc5e95fcfd1c16b--high-school-biology-your-teacher.jpg   1. **Urine is 95% water**   The nephrons of the kidneys process blood and create urine through a process of filtration, reabsorption and secretion. Urine is about 95% water and 5% waste products. Nitrogenous wastes excreted in urine include urea, creatinine, ammonia, and uric acid. Ions such as sodium, potassium, hydrogen and calcium are excreted. |

**What happens along the section of the nephron of the human kidney?**

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| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images.png  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\ADH-Nephron.gif  **Glomerulus**  This where ultra-filtration occurs- Golomerular filtrate is formed and passed out of blood to the renal tubule while blood cells and proteins remain in the blood.  **Proximal tubule**.  This where reabsorption of useful substances such as glucose, amino acids takes place. They are reabsorbed into the blood against concentration gradient by active transport. Active transport uses the expenditure of energy.  Water is absorbed into the blood by osmosis process.  **Distal tubule**  Substances that the body needs from the waste that can be reused are reabsorbed into the blood stream. These substances are usually glucose, amino acids, vitamins, water and more.  **Loop of Henle**  Substances that the body needs from the waste that can be reused are reabsorbed into the blood stream. These substances are usually glucose, amino acids, vitamins, water and more. This reabsorption usually happens in the proximal and distal convoluted tubules a  This is where also secretion process occurs. Waste ions and hydrogen ions pass from the capillaries into the renal tubule. The secreted ions combine with the remaining filtrate and become urine  Water is absorbed back to blood. ADH is produced in the hypothalamus and secreted from the Pituitary gland into the blood. This increases reabsorption of water from the urine in the renal system back into the blood**.** |

**Composition of urine with that of glomerular filtrate and plasma**

|  |  |  |  |
| --- | --- | --- | --- |
| Main substance | Plasma | Glomerular filtrate | Urine |
|  | Grams of substances per 100ml of fluid | | |
| Urea | 0.03 | 0.03 | 2.0 |
| Uric acid | 0.005 | 0.005 | 0.05 |
| Ammonia | 0.001 | 0.001 | 0.04 |
| Glucose | 0.10 | 0.10 | 0 |
| Amino acids | 0.05 | 0.05 | 0 |
| Mineral salts | 0.70 | 0.70 | 1.50 |
| Blood protein | 0.8.00 | 0 | 0 |

**Differences between urine and blood plasma**

From the above table, the following are the differences between blood plasma and urine.

|  |  |
| --- | --- |
| **Blood plasma** | **urine** |
| Contains proteins | Does not contain protein |
| Contains glucose | Does not contain glucose |
| Contains amino acids | Does not contain amino acids |
| Contains more mineral salts | Contains less mineral salts |

**NB-** Glucose, amino acids and proteins are absent in the urine. They are not excreted in the urine because they are needed by the body. Proteins on the other hand are large molecules hence not filtered out of the blood.

**Differences in composition of blood in the renal artery & renal vein**

|  |  |
| --- | --- |
| Blood in the renal artery | Blood in the renal vein |
| Contains more urea | Contains less urea |
| Contains more glucose | contains less glucose |
| Contains more water | contains less water |
| Contains less carbon dioxide | Contains more carbon dioxide |
| Contains more oxygen | Contains less oxygen |
| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images.jpeg  ADH is produced in the hypothalamus and secreted from the Pituitary gland into the blood. This increases reabsorption of water from the urine in the renal system back into the blood**.** This increases intravascular fluid and the amount of urine voided out of the body urine volume and increased plasma osmolarity**.** A diuretic increases urine volume and increases plama osmolaity. Thus ADH conserves water in the kidneys and returns water back to the general circulation. This conservation of urine acts to increase blood pressure because total intravascular fluid volume is increased. | |

**What is the function of aldosterone hormone in the body?**

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| Aldosterone hormone affects sodium, potassium, total fluid in the body, and blood pressure. If there is too little sodium in the blood, les water is reabsorbed into the blood from the kidneys, Adrenal glands produces aldesterone hormone which causes the kidneys to hold onto more sodium which leads to more water staying in the body. The more fluid the body holds onto, the higher the blood pressure may become. Potassium may decrease as the amount of aldostereone hormone increases. Aldosterone hormone directly affects the heart and blood vessels and vice versa**.**  In other words, the aldosterone hormone is a hormone produced by adrenal gland. The hormone acts mainly in the functional unit of the kidneys to aid in the conservation of sodium, secretion of potassium, water retention and to stabilize blood pressure. Overall, the hormone helps to increase the reabsorption of water and ions in the kidneys to maintain sufficient blood volume levels, stabilizing the blood pressure. |

**KIDNEY FAILURE**

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| It is a condition in which kidneys loses ability to remove waste and balance fluids. |

**Causes of kidney failure**

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| * Drop in blood pressure due to heart failure, dehydration or shock. Hence not enough blood flowing to the kidneys * Blockage of the urinary tract which leads to difficulties in elimination of urine. * Infections in the kidneys by bacteria and viruses * Illegal drug use and drug abuse * Nephrotic syndrome * Genetic diseases such as polycystic kidney disease. |

**SYMPTOMS OF HEART FAILURE**

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| * Oedema- swelling in your feet and and ankles * Too much urine or not enough urine * Rise in blood pressure caused by too much salt and water in the body. * Nausea and vomiting * Muscle cramps * Itching * Trouble sleeping |

**TREATMENT OF KIDNEY FAILURE**

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| There are two forms of treatment for kidney failure   1. Dialysis machine 2. Kidney transplant |

**THE DIALYSIS MACHINE**

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| A machine used in dialysis that filters a patient’s blood to remove excess water and waste products when the kidneys are damaged, dysfunctional or missing. The dialysis machine itself can be thought of as an artificial kidney.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\dialysis-artificial-kidney.jpeg  Dialysis machine can also be shown by the following diagram below  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\image-asset.jpeg**  A dialysis machine receives blood through a tube connected to an artery. Inside the machine, blood flows through dialysis tubing. The tubing has semi-permeable walls and is bathed in dialysis fluid which has the same concentration of substances found in healthy human blood plasma except that it does not contain any waste substances. This means that   1. Waste products such as urea, uric acid and ammonia are more concentrated in the blood than in the dialysis fluid so they diffuse out of blood and into dialysis fluid. 2. Excess water and mineral salts leave the blood and amino acids do not diffuse out of the blood. 3. Useful substances such as glucose and amino acids do not diffuse out of blood because the concentration of these substances in dialysis fluid and blood are the same. 4. Large molecules such as blood proteins and blood cells are too large to pass through the dialysis tube wall.  * The tubing inside the dialysis machine is long and narrow providing a large surface area for efficient diffusion of substances. * The dialysis machine is warmed to the same temperature as patient as patient blood to avoid cooling the blood. * The dialysis machine has filter and air bubble trap which prevents air bubbles from getting into the patient’s blood while on the dialysis machine. The air bubbles would cause blockade in the patient’s blood vessels if they get into the patient’s blood and may lead to death. The air bubbles may also cause a blood clot which interferes with supply of nutrients and oxygen. * Blood return to the body through a vein. This is easier since blood in a vein is at low pressure. * A patient usually has three dialysis sessions per week each lasting 6-8 hours which disrupts the person’s life. * As a result, the average life expectancy for a patient on dialysis is generally five years. |

**KIDNEY TRANSPLANT**

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| Kidney transplant is where healthy kidney from a human donor is given to the patient. A living donor kidney functions on average 12 to 20 years and deceased donor kidney from 8 to 12 years. |

**TOPIC FOUR: COORDINATION**

**Define the term coordination.**

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| Coordination is defined as the organization of different parts of a complex body or integration of activities so as to enable them to work together effectively and efficiently.  Metabolism is a term that is used to describe all chemical reactions involved in maintaining the living state of the cells and the organism. |

**NERVOUS SYSTEM**

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| The primary function of the nervous system is to receive information and to generate a response to a given stimulus.  Nervous system has two main parts   1. **The central nervous system** which is made up of the brain and spinal cord. 2. **The peripheral nervous system -** This is made up of nerves that branch off from the spinal cord and extend to all parts of the body. |

**STRUCTURE AND FUNCTIONS OF NEURONE/NERVE CELL**

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| Neurons are the basic functional unit of the nervous system. A neurone has a cell body which includes the cell nucleus, and special extensions called **axons** and **dendrites**. The diagram below shows the nerve fibre.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\nervous-system.jpg  Neurone- A nerve cell which carries a nerve impulse to other nerve cells in the nervous system.  A nerve cell has the following structures:   * A **cell body** gives rise to a number of extensions which can further branch at their ends to form **dendrites**. * **Dendrites** - small structure neurons which are used to communicate with each other. * **Dendrons** are the other extensions whose function is to carry messages towards the cell body. * **Axon** is the long extensions of neurons which transmits nerve impulses away from the cell body to the next neuron, * **Axons** can contain a lipid covering called the myelin sheath that helps the neuron transmit electrochemical messages quickly towards another neuron or an effector.   **Functions of the parts of a neurone**   * A **cell body**- controls all cell activities * **Dendron** - They carry /convey electrical impulses towards the cell body. * **Axon** - They transmit nerve impulses away from the cell body to the next neuron, * **The dendrite**- They carry nerve impulses from adjacent neurones into the cell body. * **Schwann-** They manufacture the protective myelin sheath around the axon of nerve fibres. * **Myelin sheath -** It has the following functions  1. Protection of the nerve fibre 2. Insulation of the nerve fibre. 3. Increases the rate of transmission of nerve impulses.  * **Nodes of Ranvier**- It has the following functions  1. Allowing nutrients and waste products to enter or leave the neurone. 2. Allowing nerve impulses to move along the neurone through a process of de-polarisation and re-polarisation. 3. Increases the rate of transmission of impulses.  * **Synapse-** on reaching a synapse, an impulse causes the release of a neurotransmitter which diffuses across the gap and triggers an electrical impulse in the next neurone. |

**What is the myelin sheath? State the functions of the myelin sheath**

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| The myelin sheath is a fatty layer that insulates the neurones/nerve cells.  The function of the myelin sheath in the nervous system include:   1. To insulate nerve nerves from each other. 2. It also protects the nerves from other electrical impulses   It quickens the transmission of nerve impulses |

**TYPES OF NEURONES AND THEIR FUNCTIIONS**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\b3115a9328d60e5acb737663d3b2aba34e32a67e.jpg**  **Relay neuron motor neuron**  **SENSORY NEURONE, RELAY NEURONE AND MOTOR NEURONE**  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images (1).jpeg**  **Functions of neurons**   * Sensory neuroines transmit nerve impulses from sensory organs (the ear, eyes, skin, nose, and tongue) to Central Nervous System. * Motor neurons transmit carry nerve impulses from the central nervous system 9brain and spinal cord) to the effectors organs (muscles and glands). * Relay neurone relay nerve impulses from the sensory neurons to the motor neurons since they connect sensory neurons to the motor neurons. |

**THE STRUCTURE AND FUNCTIONS OF SENSORY NEURON**

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| **Structures of sensory neuron**    C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\images.png  It has the cell body which is located outside the main cell.  The cell body gives rise to a nerve fibre that divides into two   1. The branch which leads to the central nervous system known **as axon.** The function of the axon is to relay impulses towards the cell body. 2. The **Dendron** that connects the cell body to the sensory organ. The function of the Dendron is to relay impulses towards the cell body.   It has only one Dendron and it is longer than the axon.  **Function of sensory neuron**  Sensory neuron transmits nerve impulses from the sensory organs to the central nervous system. |

**MOTOR NEURONE**

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| **Structures of motor neurone**  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\neuron-3_med (1).jpeg**  **C:\Users\new\Desktop\CHIVANGA\cbse_class_10_imp_bio_diagram1.jpg**  The motor neurone has its cell body being located in the central nervous system.  The cell body of motor neurone gives rise to a long axon and many dendrons called dendrites.  **Function of motor neurones**  The function of the motor neurone is to carry nerve impulses from the central nervous system to the effectors (muscles and glands). |

**RELAY NEURONE**

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**SENSORY NEURONE, RELAY NEURONE & MOTOR NEURONE**

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| **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\reflex-action.gif**  In the diagram above   * The Sensory neurone carries nerve impulses from the receptors (sensory organs) to the central nervous system. * The relay neurone relays nerve impulses from the sensory neurone to the motor neurone. * The motor neurone carries nerve impulses from the central nervous systems to the effectors(muscles and glands)     In the diagram above   * The Sensory neurone carries nerve impulses from the receptors (sensory organs) to the central nervous system. * The relay neurone relays nerve impulses from the sensory neurone to the motor neurone. * The motor neurone carries nerve impulses from the central nervous systems to the effectors(muscles and glands) |

**SYNAPSE**

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| A synapse if the microscopic gap or junction formed when two neurones meet end-to-end or when a neurone meets a muscle. |

**HOW DO NERVE IMPULSES MOVE ACROSS THE SYNAPSE?**

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| The synaptic knob or nerve endings of one neurone release neurotransmitter known as acetyl chlorine , the chemical substances filling the synapse and transmit nerve impulses from one neurone to the other.  Acetylcholine is a neuro transmitter that is responsible for carrying a nerve impulse from a sensory neurone across a synapse to the motor neurone. |

**THE CENTRAL NERVOUS SYSTEM**

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| The central nervous system controls most of the functions of the body and mind. It consists of two parts   1. The brain 2. The spinal cord   The diagram below shows the central nervous system  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\brain-section.jpg |

**THE HUMAN BRAIN**

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| The human brain controls all body functions.It is divided into two hemispheres. The two hemispheres areinterconnected by a group of nerves called **corpus callosum**.  **Function of The Right Hemishere-** It controls activities of the left side of the body.  **Function of the left hemisphere -** It controls activities of the right side of the body.  **Grey matter-** It is the outermost part of the brain  **White matter-** It is an inner larger part of the brain which is beneath the gray matter.  The brain is covered by two membranes known as meninges.The outer membrane is touch and delicate and is known as the **dura matter**.  The function of the outer membrane together with the cranium is to protect the brain from mechanical damage.  The inner membrane that covers the brain is known as **pia matter**. Pia matter is composed of blood capillaries and lymph vessels.  **Arachnoid**- It is the a space found between the dura matter and the pia matter. It consists of connective tissues, blood vessels and cerebro spinal fluid.  **Functions of the cerebro spinal fluid**   1. It distributes oxygen and nutrients to nerve tissues. 2. It protects the central nervous system against mechanical shock because of its cushioning effect. 3. it contains lymphocytes that protect the brain against infection.   **THE MAIN PARTS OF THE BRAIN**  **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\c0434852-800px-wm.jpg**  **The following are the main parts of the brain as shown in the diagram above**   1. **Cerebrum**  * It is the largest part of the brain and makes up about two-thirds of the brain. * The outside of the cerebrum is covered with a thin layer of grey matter called the cerebral cortex. Therefore, the outer layer of the cerebrum is called **cerebral cortex.** * The cerebrum is highly folded to increase the surface area for chemical activities.   **Functions of the cerebrum**   1. It is thinking centre 2. It is involved in learning, imagination and creativity. 3. It is the intelligence centre. 4. It is responsible for personality or character of a person. 5. It is responsible for emotions 6. It is involved in voluntary control of body movements such as walking, dancing and jumping. 7. It receives and interprets nerve impulses from the sense organs through receptors. 8. **Cerebellum**  * The cerebellum is found below the rear part of the cerebrum * It is divided into two parts, the left and right hemispheres. * The cerebellum is smaller in size than the cerebrum. * It has folds on its outer layer that increase surface area and hence a higher number of neurones.   **Functions of the cerebellum**   1. It coordinates body movements 2. It maintains body balance and posture. 3. It ensures dexterity in fine movements like using hands and fingers to carry out skillful tasks such as playing a guitar, sewing and typing. 4. **Medulla oblongata**  * It is located beneath the cerebellum. * It links the spinal cord to the rest of the brain.   **Function of the medulla oblongata**   * It controls involuntary responses such as breathing, blood circulation, heartbeat, digestion and swallowing.  1. **Hypothalamus-** It performs the following functions 2. It controls secretion of hormones by pituitary glands and so it is involved in homeostatic processes. 3. It is involved in temperature regulation and homeostatic responses in the body. 4. It controls hunger, thirst, sleep and wakefulness**.** 5. **Pituitary gland**  * Pituitary gland is the main endocrine gland in the body. * It works in close association with the hypothalamus. * Pituitary gland produces hormones that control production of hormones in other parts of the body. * Pituitary gland is described as a master gland because it controls the activities of other endocrine glands in the body. |

**THE SPINAL CORD**

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| C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\Figure_35_04_04 (1).jpg   |  |  | | --- | --- | | **Parts** | **Structures contained** | | Grey matter | Contains cell bodies of sensory neurone | | White matter | Contains axons of motor neurone | | Gangrion | Contains cell bodies of sensory neurone | | Dorsal root | contains sensory neurone | | Ventral root | Contains motor neurone |  * Spinal cord is an extension of the brain. It forms the central nervous system together with the brain. * The outer parts of the spinal cord contain the white matter and the inner part contains the grey matter. * It has the central canal that runs through it. * The central canal of the spinal cord is filled with the cerebro spinal fluid.   **Function of cerebro spinal fluid**   1. It protects the brain and spinal cord. 2. It supplies nutrients to nervous system tissues 3. It removes waste products from metabolism.  * It is covered by the meninges that protect it against mechanical damage. * The diagram below shows the cross-section of spinal cord   C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\UBK19eL (1).jpg   |  |  | | --- | --- | | **Parts** | **Structures contained** | | Grey matter | Contains cell bodies of sensory neurone | | White matter | Contains axons of motor neurone | | Gangrion | Contains cell bodies of sensory neurone | | Dorsal root | contains sensory neurone | | Ventral root | Contains motor neurone | |

**FUNCTIONS OF THE SPINAL CORD**

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| 1. It links the nerves of the peripheral nervous system with the brain. 2. It coordinates certain automatic responses. 3. It coordinates or brings about reflex action. |

**DIFFERENCES BETWEEN THE BRAIN AND THE SPINAL CORD**

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| **Brain** | **Spinal cord** |
| It is enclosed in the skull | It is enclosed in the vertebral column |
| Controls all activities in the body | Regulates reflex actions in the body trunks. |
| Keeps memory and is involved in intelligence | Does not play a role in memory and intelligence. |
| It is divided into different sections each performing specific roles | It is one long organ with no subdivisions. |

**REFLEX ACTION**

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| A reflex action can be defined as a rapid and automatic response to a stiumulus. |

**REFLEX ARC**

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| It is a path taken by the nerve impulse that causes a reflex action.  **The following are the steps followed by the reflex action**   1. **Receptor**- a stimulus activities a receptor 2. **Sensory neurone-** a nerve impulse travels through a sensory neurone to the central nervous system. 3. **Relay neurone-** Transmits the nerve impulse to an effector 4. **The effector**- It responds to the nerve impulse.   The importance of the reflex arc is that it produces a quick involuntary response aimed to prevent injury in an individual.  **TYPES OF REFLEX ACTIONS**   1. **Simple reflex action**   In simple reflex action, a given stimulus always produces a natural response.   * During a simple reflex action, an impulse passes through a certain pathway from the **receptor** to the **effector**. This pathway usually involves three neurones: **sensory neurone, relay neurone and motor neurone**. The stimulus isdetected by **receptor cells** in the receptor organ which forms an impulse and transmits it to the **sensory neurone.** The sensory neurone then transmits the impulse to the **intermediate neurone** in the central nervous system. The **intermediate neurone** then transmits the impulse to the **motor neurone**. The motor neurone as a result transmits the impulse to the effector organ such as the muscles which brings about a response to the stimuli.     Central canal contains cerebro spinal fluid  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\MD0919_img_10.jpg  In the figure   1. The needle is the stimulus that has stimulated the nerve ending -receptors at the tip of the finger. 2. The nerve impulses are produced by the skin receptors. The impulses travel along the sensory neurone to the spinal cord. 3. In the spinal cord the impulses are transmitted via a synapse to an interneurone-relay neurone and via another synapse to a motor neurone. This within the grey matter region of the spinal cord. 4. The finger and biceps muscles contract and bring about a sudden withdrawal of the finger eventually the whole hand. |

**TYPES OF REFLEX ACTIONS**

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| **The Two types of reflex actions include**  Examples of simple reflex actions include the following   1. **Knee kicked or jerked**   **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\9deea89d9af55556100dbc0dc74d7bc4--quadriceps-the-muscle.jpg**  Striking of the patella tendon with a reflex harmer just below the patella stretches the muscle spindle in the quadriceps muscle. This produces a signal which travels back to the spinal cord and synapses without interneurone in the spinal cord. From there motor neurone conducts an efferent impulse back to the quadriceps femoris muscle, triggering contraction. Sudden kicking movement of the lower leg in response to a sharp on the patellar tendon.   1. **Touching a hot object -** This causes quick withdrawal of the hand. It prevents burning of the hand. This occurs when a person accidently touches a hot object; they automatically jerk their hand away from the hot object. The response is relayed to the motor neurones which project out of the spinal cord to stimulate your muscles /effectors to contract causing you to snatch your hand away from the hot object.   C:\Users\new\Desktop\CHIVANGA\cbse_class_10_imp_bio_diagram3.jpg  This can also be shown by the following diagram:  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\reflex-action.gif   1. **Sudden blinking** when someone throws an object towards your eyes. This prevents the eye from possible physical injury 2. **Salivation at the sight of food.** This prepares the individual for softening and lubrication of food to make it easy to swallow. 3. **Sneezing when dust gets into your nose.** This helps in releasing and expelling the dust that may contain infectious bacteria. 4. **Constriction of the pupil** of the eye in response to the light intensity 5. **Secretion of tears** when an onion is peeled near you. The tears wash away the irritating chemicals that can damage the eye. 6. **Conditioned reflex action**   Conditioned reflex action is a quick and involuntary response that is brought about by a stimulus that is not directly related to it.  It can also be defined as an automatic rapid action in response to a stimulus which is substituted for the normal or natural stimulus. This action is also referred to as a learnt response.  **Examples of conditioned reflexes**   1. A sight of an advertsisement showing fried chicken parts and sausages may stimulate a person to salivate. In this case , the response of salivation is not brought about by the direct smell or taste of the food but the sight of it and due to past experience or memory of having enjoyed the taste of fried chicken and sausages. 2. On hot day when one sees an advertisement of an ice-cold drink one feels thirst and has the desire for that cold drink. This response is due to a previous experience of enjoying the taste of the cold drink and its thirst-quenching. 3. The knocking at the door and the response by opening of the door. 4. Cycling 5. Walking 6. Swimming 7. Driving 8. Training of animals in various skills |

**Pavlov’s experiment on conditioned reflexes**

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| Conditioned reflexes were first investigated by the Russian scientist Pavlov. In his experiments with a dog, each time he gave the dog food, he rang a bell. The dog salivated at the sight and smell of food. Pavlov repeated this procedure for the next few days. Then he changed the sequence. This time he rang the bell but he did not present any food. The dog salivated all the same. His result led Pavlov to conclude the dog’s reflex action of salivating in anticipation of being given food was conditioned by the sound of the bell, a stimulus that normally is not directly associated with salivation. |

**What is the unconditional response in Pavlov’s experiment?**

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| Pavlov said the dogs were demonstrating classical conditioning. He summed it up like: There is a neutral stimulus (the bell) which by itself will not produce a response like salivation. There is also non-neutral or unconditioned stimulus the food which will produce an unconditioned response. |

**IMPORTANCE OF REFLEX ACTION**

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| It helps to protect us without having to think. They are done to meet an emergency and occur at the level of the spinal cord. They are important because |

**EXAMPLES OF ABNORMAL CONDITIONS ASSOCIATED WITH THE NERVOUSY SYSTEM**

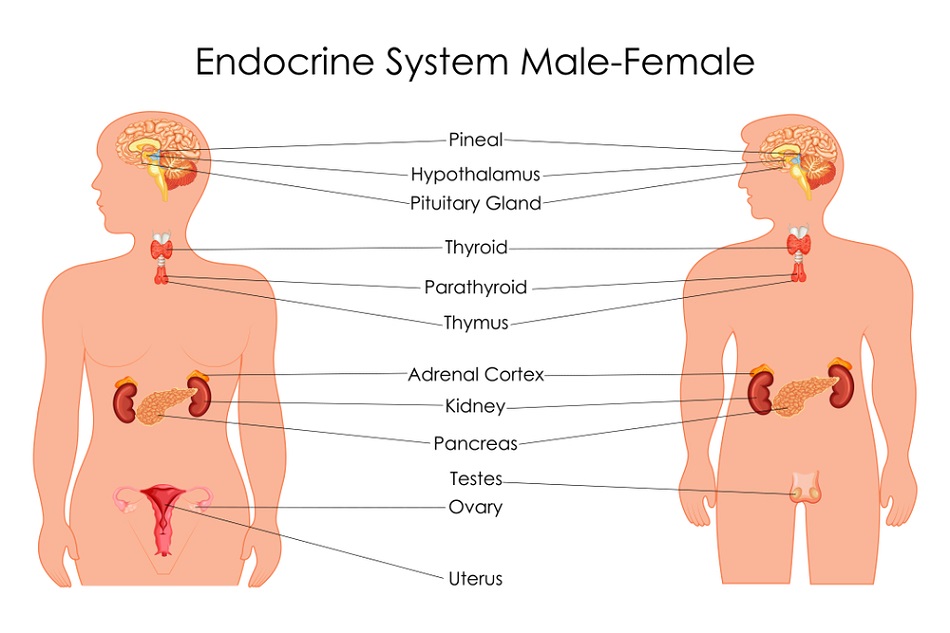
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| 1. **Poliomyelitis-polio**   It is caused by virus and it affects the Central Nervous System affecting the nerves especially sensory neurons. The polio victim is unable to transmit motor impulses from the Central Nervous System to the effectors since motor neurons are destroyed by the polio virus.  **Transmission**  Poliomyelitis is transmitted through   * Food * water * Droplet materials containing the virus that cause polio.   **Signs of poliomyelitis**   * Paralysis of muscles * Paralysis and deformation of the skeleton * Fever   **Control and treatment**   * Use of treated water making them virus free * Vaccinating children against it.  1. **Tetanus**  * It is a disease caused by **Clostridium tetani.** It is transmitted through open wound when get in contact with contaminated soils**.** It causes permanent contraction of muscles by interfering with nervous transmission.   **Symptoms**   * Muscles stay stiff and contracted due to the effect of toxins produced by the bacteria. * Death that result from paralysis of muscles of the chest which reduces oxygen availability to the muscles.   **Prevention and control**   * Vaccination   **Treatment**   * Inject antitoxins and use antibiotics * Inject muscles relax drugs  1. **Meningitis**   It is a bacterial infection of the membranes covering the brain and spinal cord-meninges. The infection causes inflammation of meninges. Bacterial meningitis infections are extremely serious and may result in death or brain damage even if treated.  **Symptoms**   * Intracranial pressure * Fever and chills * Mental status changes can lead to epilepsy * Nausea and vomiting * Sensitivity to light * Stiff neck may aggravate to coma or seizures, brain swelling   **Treatment**   * Use of antibiotics for bacterial meningitis. They will vary depending on the bacteria causing the infection. * Intravenous medication will be used to treat symptoms such as brain swelling, shock and seizures. Some people may need to stay in the hospital, depending on the severity of the illness and the treatment needed.  1. **Leprosy**   It is an infectious disease that is caused by mycobacterium leprae. It affects the peripheral nervous system. It causes permanent damage to the skin nerves, limbs and eyes**.**  **Two forms of leprosy are**   1. **Lepromatous leprosy**   This is contagious and progressive. It is known by disfiguring skin sores, nerve damage, and progressive debilitation-difficult to transmit and has a long incubation period which makes it difficult to determine where or when the disease was contracted**.**  **Symptoms**   * Skin lesions that are lighter than your normal skin colour. * Lesions have decreased sensation to touch, heat or pain * Lesions do not heal after several weeks to months. * Numbness or absent sensation in the hands, arms, feet and legs.  1. **Tuberculoid leprosy**   It is contagious and less progressive  **Symptoms**   * Loss of sensation in some parts of the skin. * Joint damage * Paralysis * Loss of fingers and toes * Muscle weaknesses   **Treatment**   * Use antibiotics to kill the bacteria which cause the infection such as Asprin prednisone or thalidomide is used to control inflammation.   **Prevention**   * Prevention consists of avoiding close physical contact with untreated people.  1. **Cerebral malaria**   This is a form of malaria that affects the brain. It occurs when malaria parasites extended beyond the blood stream and the liver into the central nervous system.  The parasites attack the meninges of the brain and the spinal cord.  **Symptoms**   * High fever * Severe headache * Vomitting   **Treatment**   * Administering quinine destroys the parasites.   **Prevention**   * Use mosquito nets all night all the year round * Anti-malarial drugs * Malaria vaccines  1. **Stroke**   A stroke is an interruption of the blood supply to any part of the brain which carries oxygen to the brain.  It can also be defined as a condition where the functions of the brain are interfered with by blockage of arteries in the brain or by bursting of a capillary in the brain leading to a clot on the nerve cells. The nerve cells where the blood vessels become inactive resulting to distorted responses.  **Causes of stroke**   * High blood pressure that may burst a vessel in the brain. * Cranial arteriole thrombosis * Shock * Depression * Heart failure   **Factors that enhance stroke**   * Old age * Hypertension * Diabetes * Smoking * Alcoholism * Injuries on the head   **Symptoms of stroke**   * Sudden severe headache especially if the stroke is caused by bleeding in the brain. * Paralysis of organs usually one side basing on which sphere of the brain has been attacked. * Symptoms usually develop suddenly and without warning. * Inability to speak * Inability to see * Difficulties in movement * Death   **Treatment**   * A stroke is a medical emergency * Immediate treatment can save lives and reduce disability * The patient needs to get the hospital as quickly as possible. |

**THE ENDOCRONE SYSTEM**

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| This is a system which is comprised of ductless glands that secrete hormones in blood stream in the body**.**  Hormones are chemical substances produced in one part of the body and which bring about responses in another part of the body. They are produced by endocrine glands. Hormones are carried by blood stream and used by target organs where they bring about response. |

**Why are endocrine glands described as ductless glands?**

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| Endocrine glands are described as ductless glands because they do not have special ducts to carry hormones but rather release their hormones directly into the blood stream. |

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**THE ENDROCRINE/DUCTLESS GLANDS**

**The following are the ductless glands**

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| 1. **Pituitary gland**   Pituitary gland is described as **master gland** because it controls the functioning of other endocrine glands in the body.  **Hormones produced by pituitary glands include the following**   1. **Oxytocin-** It stimulates rhythmic contractions of the uterine muscles during labour-parturition. It also causes expulsion of milk from mammary glands   **Effect of under-secretion of oxytocin hormone**  It makes birth to be delayed  **Effect of over-secretion of oxytocin hormone**  It causes premature birth.   1. **Anti-diuretic hormone (ADH)/vasopressin**   It is produced by hypothalamus in the pituitary gland  **Function**   * It controls water reabsorption in the kidney nephrons during urine production. It stimulates the kidney to absorb water. * It plays important role in osmoregulation, keeping the volume of blood and the osmotic potential of the body fluids constant. It stimulates the walls of the collecting ducts and diastal convulated tubule to be more permeable to water. More water is reabsorbed from glomerular filtrate back to the blood. This restores blood water level back to normal. When ADH is produced in less quantity, an individual suffers a condition called **Diabetes insipidus.**  1. **Prolactin-** It brings about lactation thus production and secretion of milk by the mammary glands soon after a woman has given birth. In other words, it stimulates milk production in lactating mammals. 2. **Follicle Stimulating Hormone (FSH)-** It stimulates the growth of follicles cells in the ovaries in females. It also stimulates the leyding cells to secret testosterone for sperm production in males. 3. **Adrenocorticotropic hormone-** It regulates the secretion of steroid hormones from the cortex of adrenal glands. 4. **Luteinizing Hormone-** It brings about ovulation 5. **Thyrotrophin-** It stimulates thyroid gland to secrete thyroxine hormone 6. **Somatotrophin-** It promotes growth and metabolic functions. It also stimulates growth of cartilage, bone and muscle tissue and also deposition of minerals for example calcium in bone tissue.   Low secretion of Somatotrophin leads to dwarfism and over-secretion may lead to giantism   1. **Thyroid Stimulating Hormone-** It regulates the secretion of the hormone thyroxine from the thyroid gland. 2. **Melanophore Stimulating Hormone-** It brings about expansion of melanin pigment 3. **Thyroid gland-** This gland produces **thyroxine hormone.** This hormone is comprised of iodine.Its secretion is controlled by Thyroxin Stimulating Hormone produced by Pituitary gland.   **Function of thyroxine hormone-** It controls the metabolic rate in all the  cells of the body including the rate of glucose metabolism in the cells.  **Effects of thyroxin under-secretion**   * **Cretinism**-It results in retarded skeletal growth and mental development in children. * **Myxoedema**- results in fat accumulation in the skin in adults. Sluggishness and mental slowness.   **Adrenal glands-** TheyIt produces adrenaline hormone. The function of adrenaline hormone is that it t prepares the body for emergency. It also stimulates high rate of respiration to produce more energy.  It is therefore sometimes referred to as the **fright hormone, emergency hormone or combat hormone.**  The hormone is involved in response to danger, anxiety, excitement and emergency.   1. **Pancreas-** It contains Islets of langerhan cells that secrete insulin hormone**.**  * The Function of insulin hormone is that it promotes conversion of excess glucose in the blood into glycogen in the body. Glycogen is stored in the liver. Insulin decreases glucose concentration in the blood if the concentration rises above normal. It also increases use of glucose to eliminate excess glucose in the blood. * The other function of the insulin hormone is that it stimulates conversion of excess glucose to lipids that are then stored by the body.   **Effect of deficiency of insulin production**  If the pancreas produces insufficient insulin, an individual suffers from a disease called **diabetes mellitus or sugar disease.**  Therefore, diabetes milletus is a condition in which the pancreas fails to produce insulin if produces inadequate amounts of insulin. A person with diabetes mellitus an abnormally high level of glucose in the blood.  **Symptoms of diabetes mellitus**   1. Passing out urine frequently 2. Constantly feeling tasty. 3. Dehydration 4. Loss of weight 5. Poor resistance to infections  * The islets of langerhan cells of pancreas also produce **glucagon hormone.** * The function of the glucagon hormone is that it increases concentration of glucose in blood. It stimulates the liver to convert glycogen into glucose when the level of glucose in blood is low.  1. **Testes-** They produce **testosterone hormone.**   The function of Testosterone hormone is that it promotes secondary sexual characteristics in males- It also promotes growth and development of reproductive organs.   1. **Ovaries-** They produce oestrogen hormone. The function of oestrogen hormone is that it promotes development of reproductive organs and secondary sexual characteristics infemales. |

**DIFFERENCES BETWEEN ENDOCRINE AND NERVOUS SYSTEMS**

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| **Endocrine system** | **Nervous system** |
| Uses chemical substance or hormones to relay impulses. | Uses electrical charges caused by concentration of chemical substance to relay impulse. |
| Hormones are transmitted through the blood. | Impulses are transmitted through nerve fibres. |
| Hormones reach all parts of the body. | Never impulses are transmitted through nerve cells connected to specific parts of the body. |
| Hormones stay longer in the blood and as a result, their effects last longer. | Impulses are short-lived and as a result, their effects last for a short time. |
| Mostly involved in growth responses and some muscle activity. | Mostly involved in muscles contractions and stimulation of hormone secretion. |
| Responses are usually slow**.** | Responses are usually fast. |

**CHAPTER FIVE -IMMUNITY**

**What is immunity?**

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| Immunity is the ability of the body to defend itself against infectious agents, foreign cells and even abnormal cells such as cancer. |

**TYPES OF IMMUNITY**

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| **Two types of immunity are**   1. **Natural immunity (innate/inborn)**   Natural immunity is the immunity that comes from within the body itself.  **Two types of natural immunity are**   1. **Active (infection) natural immunity** - This is the type of immunity that develops after recovering from a disease. The body produces antibodies very quickly after recovering from the diseases to make the body immune if the disease attacks the organism again. 2. **Passive (placenta) natural immunity**- This immunity acquired by the foetus from the mother by getting antibodies against pathogens through the placenta also through breast milk. 3. **Artificial immunity(adaptive)**   Artificial immunity is the immunity that is obtained by introducing antigens into the body of an organism to protect the organism to protect the organism from a disease.  **Types of artificial immunity**   1. **Artificial acquired active immunity**- It is the protection produced by intentional exposure of a person to antigens in a vaccine, so as to produce an active and lasting immune response. The antigens in the vaccine stimulate the immune system the immune system to produce antibodies and memory cells which are specifically directed against the antigens in the vaccine. 2. **Passive artificial immunity-** It is the transfer of immunity in the form of ready-made antibodies, that is, using antibodies produced in one organism to protect another organism from a specific disease. |

**FIRST LINE OF DEFENSE AND HOW IT WORKS**

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| These are natural ways through which the body fights against infection. The first line of defense prevents the entry of germs or pathogens into the body.  **The first line defense/external defense mechanism include**  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\5438851_orig.gif   1. **Skin**   The skin creates a barrier that protects the cells inside the body from harmful microorganisms in the external environment. In other words, the human skin forms water-proof, germ -proof and self-repairing barrier.   1. **Mucus lining of respiratory tract**   The mucus that that is produced by mucus membranes in the lining of all body openings trap the germs and dust breathed in together with air through the nose or mouth so that they do not reach the lungs. The trapped germs and dirty are then carried by cilia to the gullet where they are swallowed and eventually passed out of the body through faeces.  The cilia in the nasal cavity and trachea trap dirt and germs and they are coughed out or sneezed out.   1. **Acids in the stomach/digestive system**   The hydrochloric acid produced by the stomach kills bacteria that come into the stomach with food.   1. **Tears**   Tears produced by tears glands keep the eye moist and clean away dust or any foreign particle or chemicals reaching the conjunctiva. The tears also contain a substance called lysonzyme that kills any germ that might enter the eye   1. **Earwax**   The wax produced by Sebaceous glands trap and kills the bacteria and fungi entering the ear. The wax also traps dust and keeps off insects from entering the ear canal.   1. **Vaginal secretions**   They slightly acidic that inhibits growth of pathogens   1. **Symbiotic defense**   Symbiotic is a relationship whereby two organisms live together and benefit from each other. For example, bacteria benefits from food, warmth and shelter from the baby. On other hand, the bacteria make vitamin K that is used by the baby. The bacteria also fight other bacteria that may enter the intestine to cause disease.   1. **Interferon**   These are protein compounds produced by cells which have been invaded by viruses, blocks the transcription of new viral early proteins to prevent the infection   1. **Blood clotting**   Blood clotting is the mechanism that prevents blood loss from the broken vessels. When blood vessel is broken, platelets or damaged cells release chemical substance known as **prothrombin** into the blood plasma and causing the production of enzyme **Thrombin**. **Thrombin** turns the soluble plasma **fibrinogen** into its insoluble fibrous form **Fibrin**. **Fibrin** binds together platelets and blood cells to form a **clot** at the site of the wound. When a clot is formed, it blocks further loss of blood and prevents microorganism entering the body through the point of injury. This reduces chances of infection.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\58f52d5901672aeca9179c11be28087c.jpg  . |

**SECOND LINE OF DEFENSE/INTERNAL DEFENSE MECHANISM**

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| It is the natural immunity that become into operation when the germ has gained entry into the body after the first line of defence has been defeated.  The second line of defence is provided by the **action of the phagocytes** and **the action of lymphocytes/antibodies.**   1. **Action of the phagocytes**   Phagocytes are white blood cells which destroy germs by engulfing and digesting them in the blood and tissues. Other phagocytes are attached to walls of lymph nodes where they destroy germs in the lymph. The diagrams below represent phagocytes.     1. **Action of lymphocytes/antibodies**   Lymphocytes are white blood cells that produce antibodies which destroy, disintegrate or inactivate pathogens.  The following are the types of lymphocytes   1. **B-lymphocytes**   They produce antibodies that destroy germs by either dissolving them or neutralizing them.   1. **T-lymphocytes**   They either attack pathogens directly or produce chemicals which coordinate the activity of all cells in the immune system.   1. **T-helper cells**   They are middlemen in the immune response. When they get activated, they secrete cytokines that regulate or help effectors lymphocyte function. HIV attack T-helper cells.  **HOW T-CELLS WORK**  **T-cells** are a subset of lymphocytes that play a large role in the immune system response. T stands for thymus, the organ in which their final stage of development occurs.   1. **Cytotoxix T-cells** destroy infected cells. These cells function as “killer” because they are able to destroy target T-cells which express specific antigens that they recognize. These cells are important in fighting viral infections and tumours. They are able to find and then destroy cells infected with a virus or a cancerous cell. Cytotoxic or T-killer cells do their work by releasing lymph toxins which cause celllysis. 2. **T-helper cells-** They are middlemen in the immune response. When they get activated, they secrete cytokines that regulate or help effectors lymphocyte function. 3. **Regulatory T-cells/Suppressor T-cells**- They suppress activation of the immune system and maintain immune system homeostasis. Failure of regulatory T- Cells to function properly may result in autoimmune diseases in which the immunocytes attack cells in the body. |

**IMMUNISATION**

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| Vaccination is the process of acquiring or inducing resistance to infection in a human being. In other words, immunization is the process of making a person immune to an antigen by giving a vaccine to make the person immune to a disease**.**  The following are the purposes of vaccination/immunization   1. To initiate the production of antibodies. 2. To initiate the mobilization of lymphocytes and macrophanages in a process called cellular immune response. |

**ABO BLOOD GROUPS**

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| * ABO blood groups are the most basic system of blood typing. It is the classification of human blood based on the inherited properties of red blood cells as determined by the presence or absence of the antigens A and B which are carried on the surface of the red blood cells. * Red blood cells of Type A have the A antigen on their surface, those of the type B have antigen B, type AB red blood cells bear both antigens A and B while type O cells bear neither antigen as shown in figure below. * Blood containing red cells with type A antigen on their surface has its serum antibodies against B (Ant- B) red cells. If in blood transfusion, type B blood is injected into persons with type A blood, the red cells in the injected blood will be destroyed by the antibodies in the recipient’s blood since there will agglutination. * Blood containing red cells with type B antigen on their surface has its serum antibodies against A (Anti -A) red cells. If in blood transfusion, type A blood is injected into persons with type B blood, the red cells in the injected blood will be destroyed by the antibodies in the recipient’s blood since there will agglutination. * Blood that does not red cells with type A antigen and type B antigen ( blood group) on their surface has its serum antibodies against A (Anti -A) red cells and antibodies against B (Ant- B). If in blood transfusion, type O blood is injected into persons with type A, B or O blood, the red cells in the injected blood will be NOT BE destroyed by the antibodies in the recipient’s blood. Hence no agglutination. **Blood group O** is the **universal donor** since the person with is blood group can donate blood to all other blood groups. * Persons with type AB can receive type A, B or O blood since it does not have antibodies in their blood plasma. Blood AB is t he universal recipient since can receive blood from all other blood groups.   This system divides blood into four groups -A, B, AB and O.    **Take note:**   * Antibodies are found in the blood plasma * Antigens are found on the surface of red blood cells. |

**BLOOD COMPATIBILITY**

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**UNIVERSAL DONOR**

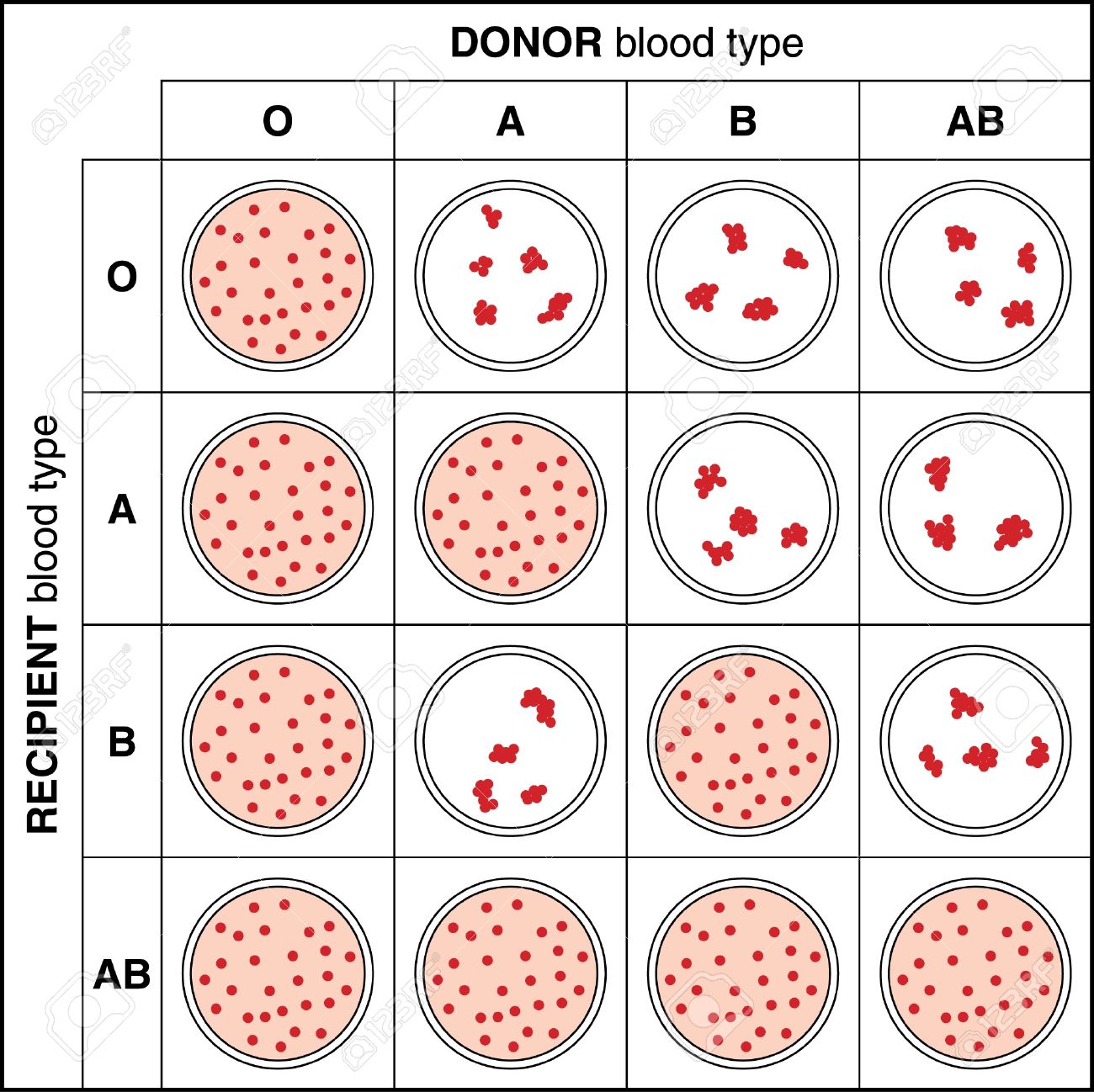
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| Individuals with type O blood do not produce antigens. Therefore, their blood normally will not be rejected when it is given to others with different ABO types**.** A s a result, type O people are universal donors for blood transfusions but they can receive only type O blood themselves |

**UNIVERSAL RECEIPIENT**

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| Individuals with type AB blood group do not make any ABO antibodies. Their blood does not discriminate against any other ABO type. Consequently, they are universal receivers for blood transfusions, but their blood will be agglutinated when given to the people with every other type because they produce both kinds of antigens. |

**TESTING BLOOD COMPARTIBILITY & INCOMPARTIBILITY**

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| It is easy and inexpensive to determine an individual’s ABO type from a few drops of blood. A **serum** containing **Anti- A antibodies** is mixed with some of the blood. Another serum with anti- B antibodies is mixed with the remaining sample. Whether or not agglutination occurs in either sample indicates the ABO type. It is a simple process of elimination of the possibilities. For instance, if an individual’s blood sample is agglutinated by anti-A antibody, but not the anti-B antibody, it means that the Anti-A antigen is present but not the anti-B antigen. Therefore, the blood types is A.  The table below shows the results for the test of blood groups. It shows where agglutination has occurred or not |

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**FACTORS TO CONSIDER BEFORE BLOOD TRANSFUSION**

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| 1. **Blood groups-** toavoid sticking together of red blood cells called agglutination. 2. **Rhesus factor-** to avoid miscarriage to pregnancies**.** 3. **HIV/AIDS** - to prevent transmission**.** 4. **Presence of hepatitis B - to avoid infection.** 5. **Syphilis- to avoid infection** 6. **Test for haemoglobin- To avoid oxygen short supply which may lead to death.** 7. **Blood pressure -test-** To avoid deaths that may occur due **to lower blood pressure.** 8. **Age of the donor us-** the blood donor too young 9. **Hepatitis**- Blood from individuals suffering from hepatitis should not be used for transfusion because virus can be transmitted through blood**.**   **GENETICS AND VARIATION** |

**Explain the causes of variation.**

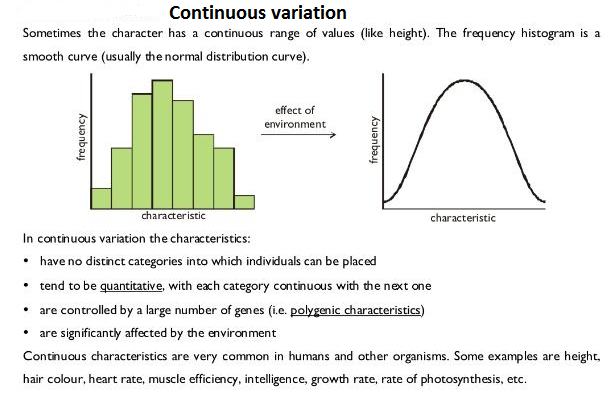
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| 1. **Heredity**   Heredity refers to the genes inherited from parents by the offspring through the gametes. During the formation of the zygote, a sperm cell from the father carries half the inherited material that is 23 chromosomes as the other half comes from the ovum. This simply explains why an offspring does not exactly resemble either the parent. This is a type of variation.   1. **Sexual reproduction**   During sexual reproduction, a zygote is formed by fusion of two cells from separate parents, male and female parents. This results to differences in characteristics of the off springs.   1. **Crossing over during meiosis**   This is the process in genetics by which the two chromosomes of a homologous pair exchange equal segments with each other. Crossing over occurs in the first division of meiosis. At that stage each chromosome has replicated into two strands called sister chromatics. The diagram below shows crossing over. During crossing over, maternal and paternal homologous chromosomes exchange segments with each other during prophase 1.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\884166_orig.gif   1. **Independent assortment**. Mendel’s law of independent assortment states that the alleles of two or more different genes get sorted into gametes independently of one another. In other words, the allele a gamete receives for one gene does not influence the allele received for another gene. The diagram below shows independent assortment   **C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\crossing_over.jpg**   1. **Random fertilization by gametes**   Random combining of gametes during fertilization produces various combinations of the variations already produced by the meiosis processes.   1. **Mutation-** Sudden changes in the structure and amount genetic material in the cells of an organism. Mutations cause changes in characteristics of an offspring. They can because by mutagens such as UV rays, cosmic rays and other chemicals. Mutations are passed on from generations to another 2. **Age -** Variation can be a result of emotional aspects that affect the muscles structure over long periods of life, effects of various hormones secreted by the body over a period of time, continues exposure to sun radiations , changes in diet and different life styles experienced at different times. |

**CAUSES OF MUTATIONS**

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| **The following are the causes of mutations**   1. Radiation   Exposure to X-ray radiation, alpha radiation, gamma radiation UV light and beta particles   1. Atomic energy 2. Rise in temperature 3. Chemicals |

**TYPES OF MUTATIONS**

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| 1. **Gene mutation**   Mutations that occur on genes. It is when part of DNA on a single chromosome is changed. This leads to the formation of defective protein or no protein formed at all.   1. **Chromosomal mutation**   Mutations that occur chromosomes. It occurs when cell division fails to work with complete accuracy. These are changes in the chromosome number or structure.  **Types of chromosomal mutations**   1. **Non- disjunction**   This occurs when homologous chromosomes fail to separate during anaphase 1 of meiosis. This leads to a situation where some daughter cells (gametes) carry more number of chromosomes while others carry fewer.  **Effects or non-disjunction disorders**   * Non-disjunction occurring in sex cells may lead to formation of gametes with extra chromosomes and others with fewer chromosomes in their nucleus. * In a successful fertilization involving such gametes then defective zygote are formed.   **Examples of effects or non-disjunction disorders**   1. **Down’s syndrome** 2. **Klinefelter** 3. **Chromosomal mutation** |

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**Differences between continuous variation and discontinuous variation**

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| **Continuous variation** | **Discontinuous variation** |
| Deals a few genes | Deals with many genes |
| Deals with a few clear cut phenotypes | Deals with a spectrum phenotypes ranging from one extreme to the other |
| Genes do not show additive effect | Genes show additive effect, for example, the more ‘dark’ genes, the darker will be the skin colour. |
| Not modified by the environmental changes | Modified by environmental conditions such as greater exposure of the skin to sunlight will produce a darker skin colour. |

**CHAPTER SEVEN - EVOLUTION**

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| Evolution theory tries to explain how the great diversity of animals and plants that exist on earth today has come to be. It suggests that life on earth began from simple forms that then slowly evolved into the present day organisms. |

**SCHOOL OF THOUGHTS OF EVOLUTION**

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| **The following are the four theories that support evolution:**   1. **Creation Theory**   This is belief that life originate from the creator. Creation is the process by which something is brought into existence out of nothing**.** The theory is based on the idea that life was created by a supernatural being (God) at a particular time. According to the theory, creation occurred once and the organisms created have remained unchanged over time.   1. **Spontaneous Generation Theory**   Under this theory, people believe that life started as an abruptly bang. They hold that life started with the evolvement of oxygen gas from methane and hydrogen**.** They believed in life originating from non-living things. They hold that simple life of worm started from the rotten meat. The idea was disapproved; the worms were the maggot larvae.   1. **Lamarck’s Theory**   Lamarck theory is the notion that an organism can pass on to its offspring physical characteristics that the parent organism acquired though use or disuse during its life time. Jean Baptiste Lamarck proposed “The inheritance of acquired characteristics “. He proposed that organism’s effort s to efforts to adapt to the environment can be accumulated and passed on to their offspring. He further proposed that by using or not using its body parts, an individual tends to develop certain characteristics which it passes on to its offspring.    **EXAMPLES OF LAMARCK’S THEORY**  A giraffe acquired its long neck because its ancestor stretched higher and higher into the trees to reach leaves, and that the animal’s increasingly lengthened neck was passed on to its offspring.  C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\1200-607791-8116585.jpg  **THE DEVELOPMENT OF LONG NECKS IN GIRAFFES**   1. **Darwin theory**   **State Darwin theory of evolution.**   * Darwinism is a theory of biological evolution developed by the English naturalist Charles Darwin (1809-1882) and others stating that all species of organisms arise and develop through the natural selection of small, inherited variations that increase the individual’s ability to compete, survive and reproduce.   **On the Origin of Species by Means of Natural Selection**   * Charles Darwin wrote a book in 1859: “ **On the Origin of Species by Means of Natural Selection”**   C:\Users\new\AppData\Local\Temp\WPDNSE\{00000008-0001-0001-0000-000000000000}\Evolution-cartoon_opt-608x251.jpg |

**THE PIECES OF EVIDENCE THAT SUPPORT THE THEORY OF EVOLUTION**

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| Evolution is backed by beliefs, facts and assumptions which can be believed, accepted or challenged.  Therefore, the following are the pieces of evidence that support the theory of evolution:   1. **Fossil records- Paleontology**  * Fossil records are remains or traces of organisms that inhabited the earth in the past. Paleontologists arrange fossil information in series according to their age, from oldest to most recent. This is referred to as fossil record. These remains are preserved in natural materials such as sedimentary rocks, resin and amber. * Fossils are the remains of plants and animals which used to live millions of years ago. * Fossils study may be of organisms which existed but no longer live such as Dinosaurs. * Fossils of species which existed in past might slightly be different from similar species today. For example, early horse was smaller than present day horses. * In 1970s, paleontologists noticed that Archaeopteryx shared unique features with small carnivorous dinosaurs called theropods. The birds are simply a twig on the dinosaurs branch of the tree of life. AS birds evolved from these theropod dinosaurs, many of their features were modified.  1. **Geographical distribution**  * It is believed that there was only one continent, the continent of Pangaea. This time animals were freely migrating from one place to another. The splitting of the land into seven continents by continental drift has caused the isolation of similar organisms. These organisms are exposed to different climatic conditions and environment. Related organism occupying similar climatic regions on different continents are different.   **Adaptive radiation**- It is the process of evolution starting from a single ancestral type of animal and giving rise to different forms and species each occupying different niches.  Examples   1. The lion of Africa and tiger in Asia 2. The camel in Africa and Hammas in South America 3. Short tailed monkey and Apes in Africa and long tailed monkeys in South America. 4. **Cell biology**   Cell organelles such as mitochondria, endoplasmic reticulum, nucleus and Golgi bodies have been found to be of universal occurrence in the cells of nearly all living things. The presence of certain molecules such as ATP, DNA and RNA also occur universally. The presence of such organelles suggests that these organisms had a common ancestry. For example, humans and chimpanzees have similar molecular structures suggesting that they are closely related.   1. **Comparative embryology**   Embryology is the study o the development of embryos from fertilization until they become fetuses or the point at which you can distinguish the species. Comparative embryology is the branch of embryology that compares and contracts embryos of different species showing how all animals are related. Embryology is the comparative study of embryos of different animals. In other words, comparative embryology is the comparison of embryo development across species. Embryonic is a new method of examining evidence of evolution. Embryo structures of different species show significant similarities. By studying the same patterns of early development across many different animals, we can find evolutionary links between animals. Closely related organisms go through similar stages in their embryonic development because they evolved from a common ancestor. For example the vertebrate embryos go through a stage in which they have fish like gill slits and tail.    The study of embryological development of different vertebrates such as fish, birds and human beings, shows very striking similarities at one stage during their development. These similarities indicate a common ancestral origin of vertebrates.  The diagram below shows pent dactyl in structure vertebrates. C:\Users\new\Desktop\CHIVANGA\images (2).jpeg   1. **Comparative anatomy**   It is the study of the structural similarities and differences between organisms. Under comparative anatomy, there are two forms of evolution.  Importance- presence of similarities provides evidence for evolutionary relationships between species.   1. **Divergent evolution**   Certain structures when compared, suggest evolution from the same ancestor. Such evolution can be described as **divergent evolution**.  **Homologous structures**  These are structures with similar basic form and a common embryonic origin but are modified to perform different functions in different organisms.  **Examples of homologous structures**   * Flowers in plants * Pent dactyl limbs in vertebrates used for walking or grasping things * Beaks of birds * Mouth parts in insects   The presence of a common basic form indicates a common ancestry for such organisms.  The modification of a homologous structure to enable an organism to exploit a particular environment is known as **adaptive radiation**.   1. **Convergent evolution**   **Convergent evolution** is the form of evolution where the evidence of evolution is shown by analogous structures that show that during evolution, dissimilar structures can become modified to suit a particular function. Some other structures when compared suggest evolution from different ancestors. Such evolution is referred to as convergent evolution.  In convergent evolution, different groups of organisms develop the same adaptations because they exist in the same type of environment.  Analogous structures do not indicate close relationships. They suggest that organisms with such structures have evolved from different ancestors.   1. **Comparative serology**   This is where animals that are more phylogenetically related contain more similar blood proteins-antigens. The reaction between antigens antibody of animals produces a precipitate when sera of different animals are mixed together showing a phylogenenetic relationship.   1. **Existence of drug resistance organism**   New species of organisms that are resistant to drugs have arisen through the process of evolution.  **Examples**  TB bacteria that cause incurable TB is a new strain of bacteria that is resistant to penicillin. |

**MECHANISMS OF EVOLUTION**

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| 1. **Mutation-** Mutation, driving force of evolution, is random change in a population’s gene pool. It is a change in the nature of the DNA in one or more chromosome chromosomes. Mutations give rise to new alleles; therefore, they are the source of variation in a population. 2. **Gene flo.** This occurs during the migration of individuals from one group to another. 3. **Genetic drift** |

**NATURAL SELECTION**

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| * It refers to mechanism by which an organism that is best suited to its environment will survive and pass on its beneficial traits in increasing numbers to the following generations whilst those organisms less suited to the environment will be eliminated. * Natural selection ensures that only the best suited individuals develop to maturity are reproduced for the next generation. |

**TYPES OF NATURAL SELECTION**

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| 1. **Stabilizing selection** - This occurs when the environment continually eliminates individuals at extremes of a population**.** 2. **Disruptive selection-** This is where the environment favours extreme types in a population at the expense of intermediate forms thereby splitting the population into two or more populations. 3. **Directional selection -** This is where the environment acts for or against an extreme characteristics and the likely result is the replacement of one gene group with another gene group. An example of directional selection is the development of antibiotic -resistant bacteria. |

**EXAMPLES OF NATURAL SELECTION IN ACTION THAT AFFECT THE POPULATION OF ORGANISMS IN THE ENVIRONMENT**

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| 1. **Antibiotic resistant bacteria -** This is the ability of bacteria to survive an attack by an antibiotic and is an excellent example of natural selection at work. Bacteria that develop a mutation that allows them to survive an antibiotic will live long enough to reproduce and so spread the survival gene to subsequent generations. Those bacteria with this gene will survive and become more numerous in the bacterial population. 2. **Fast -evolving deer mouse-** The deeper mouse evolved a pale coat that helped it to evade predators. It is mostly found across North America. 3. **In a habitat there are brown bugs and green bugs-** The birds prefer the taste of the brown bugs, so soon there are many green bugs and few brown bugs. The green bugs reproduce and make more green bugs and eventually there are no more brown bugs. 4. **Peppered moths -Industrial melaninsm-** The peppered moths of northern England originally were light coloured and so blended in with the light bark of trees. However, due to the Industrial Revolution soot and particulate matter covered trees making them darker and so the light coloured moths stood out like sore thumbs. They became easy pickings for predators. The dark body colour in the moth is due to a pigment called melanin whose occurrence is caused by mutation. 5. **Deer mice** that migrated to the sand hills of Nebraska changed from dark brown to light brown to better hide from predators in the sand. 6. **Sickle cell anaemia-** Sickle cells anaemic are individualsare all sickle-shaped and sickle cell trait individuals whose red blood cells are a mixture of normal cells and sickle shaped cells. The development of sickle cell individuals is influenced by natural selection. |

**SPECIATION**

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| * Speciation is the formation of new species. In other words, speciation is the process by which new species are formed from pre-existing ones. * A species is a group of individuals that share a number of features and are able to interbreed with another. * A species is also defined as a population whose members share a common gene pool. |

**THE FACTORS THAT BRING ABOUT SPECIATIONS**

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| 1. **Natural selection-** Natural selection causes evolution because with time and over many generations, favourable adaptations accumulate in a given group of organisms while the unfavorable variations slowly disappear. 2. **Geographical isolation-** Population selection may split and get separated as a result of geographical isolation. Organisms of same species that used to live in one habitat ends up being taken to different habitat. The isolated populations over time may undergo adaptive radiation as a result of natural selection taking place. 3. **Reproductive isolation**  * Speciation can also occur when reproductive barriers develop. For example, when members of a population develop anatomical barriers that make mating with other members of the population difficult, a new species can develop. |

**SYMPATRIC SPECIATION**

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| * This is a form of speciation that occurs when species diverge like the apple maggot flies without a complete, physical barrier. |