

dependent factors), indirectly affecting the carrying capacity of the environment.

21. a) why do different enzymes have different optimum PH? 2 marks  
 b) What is the difference between a reversible and an irreversible enzyme inhibitor? 4 marks  
 c) Explain the term cofactor and give two examples of cofactors. 4 marks

Answer:

- a) The number of  $H^+$  or  $OH^-$  ions in a solution affects the distribution of charges over the surface of the enzyme. The pH affects the ionization of side chain in amino acid residues and affects the hydrogen bonds and di-sulphur bridges which hold the enzyme in 3D shape. Extremes of pH denature the enzyme.

b)

Reversible enzyme inhibitor	Irreversible enzyme inhibitor
Binds loosely to the enzyme and reduces its activity	Binds permanently to enzyme
Can be removed without permanent damage	Once removed from the enzyme, it causes permanent change.
Inhibition can be reduced when the concentration of correct substrate is increased	Inhibition cannot be reduced by the increase of concentration of correct substrate.
e.g: malonate inhibits the enzyme succinate deshydrogenase (in krebs' cycle)	e.g: Arsenic and cyanide permanently damage respiratory enzymes.

- c) A cofactor is a non-protein chemical compound or metallic ion that is required for a protein's biological activity to happen. These proteins are commonly enzymes, and cofactors can be considered "helper molecules" that assist in biochemical transformations.  
 Examples:  $NAD^+$  (nicotinamide adenine dinucleotide) and FAD (flavin adenine dinucleotide)

### ADVANCED LEVEL BIOLOGY NATIONAL EXAMINATION PAPER 2012 (BCG, MCB, PCB)

#### SECTION A: Answer ALL questions /70 marks

01. a) What is cell's protoplast? 1 mark  
 b) List two processes carried out by the cell's protoplast? 3 marks

Answer:

- a) Cell's protoplast is a part of plant cell which lies within the cell wall and can be plasmolysed and which can be isolated by removing the cell wall by mechanical or enzymatic procedure.  
 b) Some of these processes are:

By *KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL*  
 Phone N<sup>o</sup>: 0788629451 / 0728629451, Email: *kayser132002@yahoo.fr*

1. The protoplast in culture can be regenerated into a whole plant.
2. Hybrids can be developed from protoplast fusion.
3. It is easy to perform single cell cloning with protoplasts.
4. Genetic transformations can be achieved through genetic engineering of protoplast DNA.

02. a) Give three properties of cell membrane? 3 marks

b) Name two other membranes in the cell with similar properties as the cell membrane. 2 marks

Answer:

a)

- ☐ The hydrophilic head and hydrophobic tails of the phospholipid molecules that form the phospholipid bilayer of the cell membrane - forming its physical / mechanical structure.
- ☐ The ion channels responsible for the selective permeability of the cell membrane.
- ☐ Membrane pumps that enable active transport of specific molecules across the cell membrane
- ☐ Carrier proteins and receptor proteins that transport specific substance(s) across the cell membrane and receive (chemical) signals from outside the cell that tell the cell to take a specific action, respectively.
- ☐ Cholesterol molecules and carbohydrate chains that support the structure of the membrane and its attachment to other tissues, respectively.
- ☐ Surface protein markers that identify the cell.

b) - Mitochondrial membrane

- Chloroplast membrane

- Lysosome membrane

- Endoplasmic reticulum

- Golgi bodies membranes

03. a) There are many types of proteins in a membrane. Describe the role of any two proteins. 2 marks

b) State two roles of cholesterol in the membrane. 2 marks

Answer:

a) Proteins:

- Integral membrane proteins: These proteins are involved in accumulation and transduction of energy, and proteins responsible for cell adhesion.
  - Lipid-linked proteins: these serve to transport triacylglycerols and cholesterol in the blood plasma.
  - Peripheral membrane proteins:
- Peripheral membranes allow many molecules to be carried around the cell.



- b) It helps maintain the integrity of these membranes, and plays a role in facilitating cell signaling which means the ability of your cells to communicate with each other so you function as a human, rather than a pile of cells.
04. a) Name the solvent for all the materials that are transported around the plants. 1 mark
- b) Explain the processes that are involved in the transport of sap in the following tissues.
- The xylem. 2 marks
  - The phloem. 2 marks

Answer:

a) Water

- b) i) Xylem sap rises against gravity, without the help of any mechanical pump, to reach heights of more than 100m in the tallest trees.

**Transpiration-Cohesion-Tension: A Mechanism to Pull Xylem Sap up the Plant**  
Stomata open up during the day to let CO<sub>2</sub> in and inadvertently let H<sub>2</sub>O escape

- There is a gradient in water potential, high water potential in the soil and very low water potential in the air
- Water vapor leaves the air spaces of the plant via the stomates
- This water is replaced by evaporation of the thin layer of water that clings to the mesophyll cells
- Remember, water has strong adhesive and cohesive properties - as the water leaves, it is replaced by water clinging to the inside of the cell walls
- This creates a tension (pulling) on the water in the xylem and gently pulls the water toward the direction of water loss
- The cohesion of water is strong enough to transmit this pulling force all the way down to the roots
- Adhesion of water to the cell wall also aids in resisting gravity
- As we said before, the water column in the tallest trees can be 100m - the tension created by evaporation of water coupled with the cohesive and adhesive forces is enough to support this column against the forces of gravity
- **Root Pressure: A Mechanism to "Push" Xylem Sap Up the Plant**  
At night, transpiration is almost nil. However, the root cells continue to actively transport minerals into the stele (the root stele is basically everything surrounded by the endodermis - primarily the xylem and the phloem).
  - This active transport lowers the water potential within the stele
  - Water passively flows into the roots, pushing the water up against gravity
  - Water that reaches the leaves is often forced out, causing a beading of water upon the leaf tips known as guttation

- In most plants, however, root pressure is not the primary mechanism for transporting the xylem
- Tall trees generate almost no root pressure (the weight of the water pushing down on the xylem more than counteracts any generated root pressure)

ii) Phloem is the living tissue that carries organic nutrients (known as photosynthate), in particular, sucrose, a sugar, to all parts of the plant where needed. The phloem is concerned mainly with the transport of soluble organic material made during photosynthesis. This process of transportation is called translocation.

Translocation - the process of moving photosynthetic product through the phloem

- In angiosperms, the specialized cells that transport food in the plant are called sieve-tube members, arranged end to end to form large sieve tubes
- Phloem sap is very different from xylem sap  
sugar (sucrose) can be concentrated up to 30% by weight
- Phloem transport is bidirectional  
Phloem moves from a sugar source (a place where sugar is produced by photosynthesis or by the breakdown of sugars) to a sugar sink (an organ which consumes or stores sugar)

#### The Mechanism of Translocation in Angiosperms

- Phloem loading results in a high solute concentration at the source end of the
  - This creates hypertonic conditions in the phloem, causing water to flow into the phloem
  - Hydrostatic pressure builds in the sieve tube, but it is greatest in the source
- At the sink, osmosis occurs with the unloading of sugar - water flows out of the phloem
- The buildup of pressure at the source and the reduction of that pressure at the sink causes water to flow from source to sink, carrying the sugar along with it.
  - Water is recycled via transport in the xylem
- This explanation is very simplified - scientists are just now discovering the subtle details of phloem movement in plants

05. Explain two differences between Xylem and Phloem. 2 marks

Answer:

	Phloem	Xylem
Function	Transportation of food and nutrients	Water and mineral transport from

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL

Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr



	Phloem	Xylem
	such as sugar and amino acids from leaves to storage organs and growing parts of plant. This movement of substances is called translocation.	roots to aerial parts of the plant.
Movement	Bidirectional (Moves up or down the plant's stem from "source to sink")	Unidirectional (Moves up the plant's stem)
Occurrence	Roots, stems and leaves. transports sucrose to growth (roots and shoots) and storage regions of the plant (seeds fruit and swollen roots)	Roots, stems and leaves
Additional Functions	Forms vascular bundles with xylem	Forms vascular bundles with phloem and gives mechanical strength to plant due to presence of lignin cells. The lignified secondary wall also makes the xylem waterproof and prevent it from
		collapsing under the pressure of water transpiration
Structure	Elongated, tubular shape with thin walled sieve tubes. The sieve tubes have pores at each end in the cross walls and <u>microtubules</u> that extend between sieve elements allowing longitudinal flow of material.	Tubular shape with no cross walls which allows a continuous column of water + facilitates more rapid transport within the xylem vessels. There are two types - protoxylem (first formed xylem) + metaxylem (mature xylem) depending on pattern of lignin.
Elements	Sieve tubes, companion cells, phloem parenchyma (loosely packed resulting in intercellular spaces which allows gas exchange), bast fibers, intermediary cells,	Tracheids, vessel elements, xylem parenchyma (loosely packed resulting in intercellular spaces which allows gas exchange), xylem sclerenchyma

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL  
 Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr

	Phloem	Xylem
Nature of tissue	Living tissue with little cytoplasm but no nucleus/tonoplast.	Dead tissue at maturity so it is hollow with no cell contents
Shape	Phloem is not star shaped.	Xylem is star shaped.
Location in vascular bundle	Phloem occur on outer side of the vascular bundle.	xylem occupy the center of the vascular bundle.

06. Plants constantly lose water by evaporation.

- Explain how plants compensate for this. 1 mark
- Describe one benefit of transpiration stream for a plant. 2 marks

**Answer:**

- The water lost through transpiration is compensated by absorption of water by the plant roots. It is transported to the leaves by ascent of sap.
- 

- Excess water getting into the plant might decay the cells. Transpiration prevents it by removing the extra water.
- Extra quantity of water, if retained would disturb the osmotic relationship between cells. This is prevented by transpiration.
- Transpiration stream helps in the distribution of nutrients to all the parts of the plant body.
- Fresh and cool water reaches all the parts of the plant body and this reduces the metabolic heat acting as a coolant.

07. Explain why the gut of a carnivore needs to be short with fewer infoldings than that of herbivores. 3 marks

Protein which is in the food carnivores eat is much easier to digest than cellulose which is what is in a herbivores diet.

**Or**

Carnivorous animals consume meat which is easy to digest whereas herbivores consume grass (plant products) which consists of tough cellulose which is hard to digest.

- Explain the difference between closed and open systems of circulation. 2 marks
- When comparing the two types of closed circulatory systems, explain why a double circuit is more efficient than a single circuit. 3 marks

**Answer:**

- Differences:

*By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL  
Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr*



Closed circulation	Open circulation
Present in annelids and vertebrates	In invertebrates (arthropods)
Blood does not bath the cells	Blood directly bathes the cells
Blood flows in vessels	Blood flows in haemocoel
There is a muscular heart	There is not heart but nodes as simple hearts
Higher blood pressure	Lower blood pressure
Blood contains haemoglobin	There is no haemoglobin
E.g: Earthworm, fish, frog, human	E.g: insects, arachnids

- b) A closed double circuit keeps the oxygenated and deoxygenated blood separate, which means oxygenated blood can be transported to organs quicker than in a closed single circuit, where all the blood is kept in one circuit.

09. a) The liver produces bile. Briefly state two main functions of bile in the digestion. 2 marks
- b) Describe how bile is considered an excretory product as well as a digestive secretion. 2 marks
- c) Name two principal hormones controlling the production and release of bile and state the effect of each. 4 marks

Answer:

- a) Bile acids have an emulsifying ability that breaks down lipids, and they also work as lipid carriers to transport fats through an aqueous environment. In addition to aiding the digestion of fats and fat-soluble vitamins, bile helps to eliminate waste products from the body.

Or

1. Assists with fat digestion and absorption in the gut.
2. Is a means for the body to excrete waste products from the blood.

b)

c)

- Cholecystokinin (CCK) - is in the duodenum and stimulates the release of digestive enzymes in the pancreas and the emptying of bile in the gall bladder.

10. Briefly explain the role each of the following has in a mammalian locomotion.

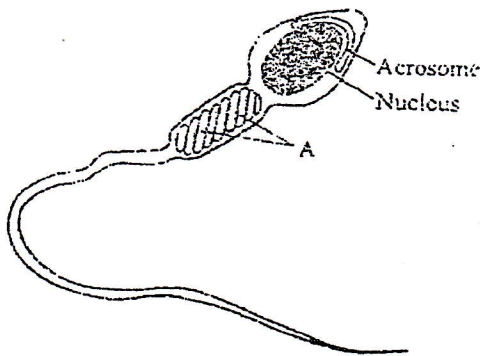
- a) Ligament. 1 mark
- b) Tendon. 1 mark
- c) Bones. 1 mark
- d) Joints. 1 mark

Answer:

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL  
Phone N<sup>o</sup>: 0788629451 / 0728629451, Email: kayser132002@yahoo.

- f) A ligament is a small band of dense, white, fibrous elastic tissue.<sup>[7]</sup> Ligaments connect the ends of bones together in order to form a joint. Most ligaments limit dislocation, or prevent certain movements that may cause breaks. Since they are only elastic they increasingly lengthen when under pressure. When this occurs the ligament may be susceptible to break resulting in an unstable joint. Ligaments stabilise the joints by holding the articulating bones together.
- g) Tendons help to transmit the forces to the relatively rigid bones, pulling on them and causing movement. Tendons can stretch substantially, allowing them to function as springs during locomotion, thereby saving energy.
- h) Bones enable body movements by acting as levers and points of attachment for muscles.
- i) A joint's function is to bear weight, perform work and exhibit a particular range of motion during movement where two or more bones come together for the purpose of movement.

11. The diagram below shows the structure of a human sperm.



- a) Explain the part played by the organelle labeled A in the process leading to fertilization.  
2 marks
- b) The acrosome contains an enzyme that breaks down proteins. Describe the function of this enzyme in the process leading to fertilization. 2 marks

Answer:

- a) Roles of the part A in the process of fertilization:
  - Site of ATP production
  - Site of aerobic respiration
  - Site of energy production required for beating of flagellum through the female reproductive tract towards ovum.
- b) Roles on acrosome enzymes in the process of fertilization:
  - They enable sperm to penetrate oocyte/ ovum membrane/ zona pellucid
  - They disperse follicle cells which surround female gamete/ egg.

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL  
Phone N<sup>o</sup>: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr



12. The turnover number of an enzyme is defined as the number of substrate molecules converted to product by one molecule of enzyme in one minute. In an experiment carried out at 20°C, the turnover number for an enzyme was found to be 2500 at the start of the experiment, but dropped to 1000 after 5 minutes.
- Suggest why the turnover number decreased after 5 minutes. **2 marks**
  - How do you expect the turnover number to differ from 2500 at the start of an identical experiment but carried out at 30°C? Explain your answer.
  - Explain why it would be important to have a control in this experiment at 20°C and at 30°C.

**Answer:**

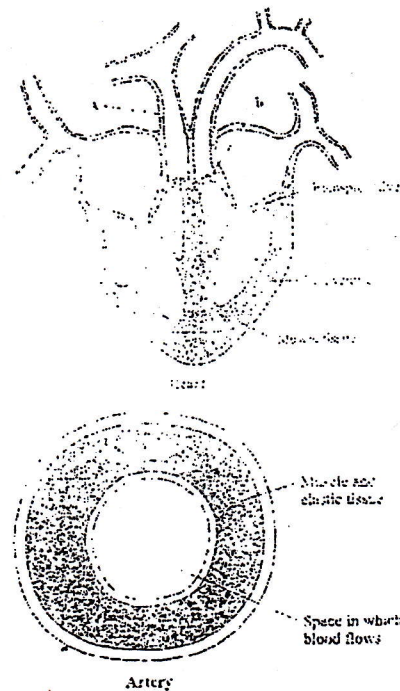
- Less substrate molecules present due to them being used up in reaction
  - Double: for every 10°C increase the rate of a chemical reaction doubles  
Or increased kinetic energy increases the rate of molecule movement.
  - To show that enzyme was responsible for conversion
13. The rate of diffusion of a molecule across a membrane depends on the relative concentration of the molecule on either side of the membrane, the membrane thickness and its surface area.

$$\text{Rate of diffusion} = \frac{\text{Concentration difference} \times \text{Surface area}}{\text{Membrane thickness}}$$

- For a maximum diffusion to take place, which factor should:
  - Be as large as possible? **1 mark**
  - Be as small as possible? **1 mark**
- Use the equation to explain how the following are adapted for efficient gas exchange.
  - A single-celled amoeba. **1 mark**
  - The human lungs. **1 mark**

**Answer:**

- Surface area
    - Thickness of the membrane
  - Surrounding membrane is small and this facilitates faster diffusion and has large surface area.
    - Thin outer membrane of alveoli cells facilitate faster rate of diffusion.
14. The diagrams show a vertical section of the heart and a cross-section of an artery.



- Name the structures labeled A and B. 2 marks
- A pulse can be felt as blood flows through an artery. Explain how tissues labeled in both diagrams help to produce this pulse. 3 marks
- What is meant by the term pulse rate? 1 mark

**Answer:**

- A: Pulmonary artery (pulmonary arch)  
B: Semi lunar valve:
  - Heart muscle contracts or ventricle muscle contracts  
- Blood forced out of ventricles  
- Expansion of artery wall/ stretching of tissues of artery.  
- Contraction of muscle in artery and recoil of elastic tissue.
  - Pulse rate = Pulse beats per minute.
15. Flower colour in pea plant is determined by two allelomorphous pairs of genes (R, r) and (S, s). If at least one pair is present the flowers are purple. All the other genotypes are white.

If two purple plants, each having the genotype RrSs are crossed, what will be the phenotypic ratio of the offsprings? Show your working. 6 marks

**Answer:**

Let Rr and Ss represent two allelomorphous pairs of genes controlling flower colour.

Parental phenotypes: Purple x Purple

Parental genotypes : RrSs x RrSs

Gametes: RS, Rs, rS, rs

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL

Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr



Gametes	RS	Rs	rS	rs
RS	RRSS: Purple	RRSs: Purple	RrSS: Purple	RrSs: Purple
Rs	RRSs: Purple	RRss: White	RrSs: Purple	Rrss: White
rS	RrSS: Purple	RrSs: Purple	rrSS: White	rrSs: white
rs	RrSs: Purple	Rrss	rrSs: White	Rrss: White

Phenotypic ratio 9 purple: 7 white.

16. Explain the role of Natural Selection in the evolution of new species. 3 marks

Answer:

The natural selection allows:

- Well adaption of individuals
- Selection of a new species
- The resistant (fittest) successes while the weak dies.

**SECTION B: Attempt ONLY any THREE questions (30 marks)**

17. a) Describe any THREE xeromorphic adaptations of plants. 3 marks

- b) How are animals adapted to survive in desert areas? 7 marks

Answer:

- a) The 3 xeromorphic adaptations of plants include reduced surface area, reflectivity, and reduced air flow to minimize evaporation rate.

b)

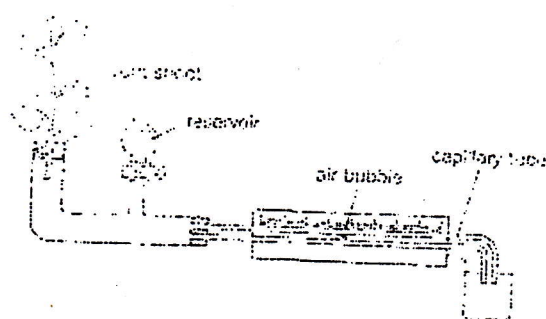
- Desert animals have found several ways to beat the heat. Most animals know the best trick. They sleep during the day and creep out during the evening hours when it's cooler. Tortoises, foxes, snakes, some lizards, and rodents all spend their days napping in underground burrows. Here the temperature stays about 86°F. The kangaroo rat even shuts the door to its burrow. He fills it with dirt to keep out the heat and any unwanted visitors. Other animals, like the desert toad, sleep much longer than a day. They bury themselves in a cool burrow and sleep right through the hottest part of the summer.
- Desert animals also have physical traits that help them handle the heat. For example, jack rabbits and foxes have large ears with lots of tiny blood veins. Heat escapes from the veins. This helps cool their bodies. Another helpful feature is a thick coat. Instead of keeping it warm, a camel's thick coat blocks out the sun's hot rays. Finally, many desert animals have light-colored fur, feathers, or scales. The pale colors absorb less heat. They help the animals hide in the sand too.
- One of the biggest challenges of desert living is not the heat but the lack of water. Desert animals must find ways to obtain enough water in their diet. One animal solves this problem by making its own water. The kangaroo rat eats dry seeds, but its body changes the seeds into food and water. This animal never needs to take one drink during its lifetime!
- Other animals, like snakes, get water from the prey they eat. Still others get water when they eat plants. Leaves and cacti contain lots of liquid. Of course, some animals do need to take a drink, and the camel can take the largest drink of all. It may gulp down thirty gallons in ten minutes! Some people

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL  
Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr

assume this water is stored in the camel's hump, but actually the hump only stores fat. The water a camel needs to survive is stored in its blood and cells.

- Today, many animals live successfully in the deserts around the world. In the Sahara Desert alone, there are forty different kinds of rodents, such as mice and gerbils. There are almost on hundred kinds of reptiles. These creatures all have one thing in common. They have learned to adapt to their hot, dry home.

18. The figure below is a simple photometer used to investigate the rate of transpiration under different conditions.

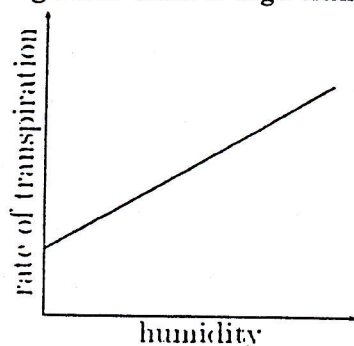


What do you think would happen to the rate of transpiration under:

- High humidity?
- High wind speed?
- High temperatures?
- High light intensity? 10 marks

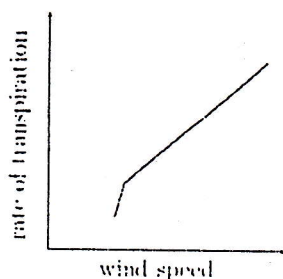
Answer:

- High humidity means a higher water potential in the air, so a lower water potential gradient between the leaf and the air, so less evaporation. But when high also there is high transpiration.

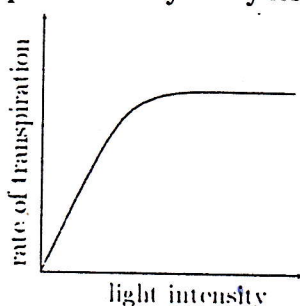


- Wind blows away saturated air from around stomata, replacing it with drier air, so increasing the water potential gradient and increasing transpiration.





- c) High temperature increases the rate of evaporation of water from the spongy cells, and reduces in humidity so transpiration increases.
- d) Light stimulates the stomata to open allowing gas exchange for photosynthesis, and as a side effect this also increases transpiration. This is problem for some plants as they many lose water during the day and wilt.



19. a) Define the following ecological terms.

- i) Population. 1 mark
- ii) Ecosystem. 1 mark

b) Discuss the various factors that influence the population growth of organisms in a closed ecosystem. 8 marks

Answer:

- a) i) Population: is a number of individuals of a particular species living in the same habitat at a particular time.
- ii) Ecosystem: is a natural unit composed of biological community (biotic components) and physical environment (abiotic components) through which energy flows and nutrients recycle.
- b) Factors that affect the growth of Populations: What is population "growth" What we might talk about as population size is actually population density, the number of individuals per unit area (or unit volume).  
Population growth is based on four fundamental factors: birth rate, death rate, immigration, and emigration.  
Population growth rate = (birth rate + immigration) - (death rate + emigration)  
"Per capita rates" are calculated as the number of events (births, deaths, or growth) divided by the number of individuals in the population over a specific time period.

- Biotic or Intrinsic factors that affect population growth: Population growth is affected by biotic or intrinsic factors that are built into the genetic basis of each species.  
Biotic or Intrinsic factors are specific to each species and include:  
The age of reproductive maturity  
The number of offspring produced per reproductive event  
The number of reproductive events in an individual's lifetime  
The three factors above are referred to together as fecundity, or the number of offspring an individual produces in its lifetime.
- Environmental Resistance Factors that Affect Birth and Death Rates:  
Environmental resistance factors fall into two categories: density dependent and density independent.

□ Density dependent environmental resistance factors

- Density dependent factors include the environmental resources needed by the individuals of a population. Competition for food, water, shelter, etc., results as the population density increases. The survival, health, and reproduction of individuals will be affected if they cannot acquire the basic requirements of life.
- Density dependent factors also include environmental factors, such as predators, infectious disease organisms, and parasites that do not necessarily result in competition for needed resources, but do affect the health, survival, and reproduction of individuals in the population as population density increases. Individuals that are diseased may have a reduced ability to reproduce. Dead individuals cannot reproduce.
- Density dependent factors are referred to as Environmental Resistance Factors that determine the Carrying Capacity of the environment for a population.

□ Density Independent environmental resistance Factors

- Density Independent factors are Environmental Resistance Factors that occur or have an effect on a population regardless of the density of the population.
- Density independent factors include weather phenomena and natural disasters that affect the population, but the chance of their occurrence or level of severity is unrelated to the density of the population.
- Density independent factors may affect the availability of resources that are required by the population (density



dependent factors), indirectly affecting the carrying capacity of the environment.

20. a) Explain the importance of mitosis. 4 marks

b) State at least six differences between mitosis and meiosis. 6 marks

Answer:

a) Mitosis is important because it is essential for growth and repair in the body.

Mitosis happens when a parent cell divides, creating two identical copies, referred to as daughter cells. During this process, it is essential that the daughter cells are exactly the same with the same copies of DNA.

When people have injuries, such as a cut on their skin, mitosis allows the body to heal itself by creating new cells to replace the damaged ones. Mitosis isn't just important for repair but for growth as well. Consider when a person grows taller: mitosis is important to this process because it creates new cells that will be needed for the growing body.

The importance of mitosis to living organisms is that it allows organisms to grow in size and repair themselves. When an organism grows, its cells do not grow larger; they divide to make more of themselves through the process of mitosis, or cell division.

b)

Mitosis	Meiosis
<ul style="list-style-type: none"> <li>• Proper to body cells</li> <li>• Comprises one division</li> <li>• No crossing over</li> <li>• The centromeres divide during anaphase</li> <li>• A mother cell produces 2 daughter cells that can divide again</li> <li>• Daughter cells are similar to their parents</li> <li>• Results to growth, replacement of the old cells and damaged cells (ones)</li> <li>• Chromosomes (chromatids) are in one line at equator region during metaphase</li> <li>• Mitosis produces 2 daughter cells which are genetically identical one another.</li> </ul>	<ul style="list-style-type: none"> <li>• Proper to reproductive cells</li> <li>• Comprises 2 divisions</li> <li>• Crossing- over of homologous chromosomes</li> <li>• The centromeres divide during anaphase II</li> <li>• A mother produces 4 haploid daughter cells not able to divide</li> <li>• Daughter cells are genetically different from mother cell</li> <li>• Reproduces gametes or reproductive cells</li> <li>• Chromosomes are in double arrangement at equator region during metaphase I</li> <li>• Meiosis cell division produces four offspring sex cells, each with only half the number of chromosomes (the haploid number)</li> </ul>

By KAYIRANGA Serge, Science facilitator, KAGARAMA SECONDARY SCHOOL

Phone N°: 0788629451 / 0728629451, Email: kayser132002@yahoo.fr

21. a) Giving examples in man, explain the following genetic characters. 6 marks

- i) Sex linked characters.
- ii) Sex limited characters.

b) How is sex determined in human beings? 4 marks

Answer:

a) i) Sex linked characters are the traits that are controlled by the genes located on sex chromosomes and are transmitted along with the sex chromosomes e.g: haemophilia; colour blindness.

ii) Sex limited characters are traits that limited to one sex e.g: menstruation and secretion of milk in females; and baldness in males.

b) In man, sex is determined by sex chromosomes X and Y. Females are homogametic i.e: their gametes carry the X chromosomes only while the males are heterogametic i.e: some of their gametes carry X chromosome while others carry Y chromosomes. The resultant sex of an offspring will depends on the nature of the gamete from the male (father) that comes to fuse the gamete from the female during the fertilization. If the gamete from the male carries X chromosome, it produces a girl ( $X+X=XX$ ). If the gamete from the male carries Y chromosome, it produces a boy ( $Y+X=XY$ ).

Parents:  $Bb Nn \times bbNn$

Gametes:  $BN, Bn, bN, bn \times bN, bn$

gametes	BN	Bn	bN	Bn
bN	BbNN Black-straight	BbNn Black-straight	bbNN Brown-straight	bbNn Brown-straight
bn	BbNn Black-straight	Bbnn Black-wavy	bbNn Brown-straight	bbnn Brown-wavy

Phenotypic ratio: 3 black-straight; 3 Brown-straight: 1 black-wavy: 1 Brown wavy

Probability of each phenotype:

Black-straight:  $\frac{3}{16}$

Brown-straight:  $\frac{3}{16}$

Black-wavy:  $\frac{1}{16}$

Brown-wavy:  $\frac{1}{16}$