

**ADVANCED LEVEL BIOLOGY NATIONAL EXAMINATION PAPER 2019**  
**(BCG, MCB, PCB)**

**SECTION A:**

1) Answer:

a) Difference between Fungi and plants

<b>Plants</b>	<b>Fungi</b>
<b>Are autotrophic</b>	<b>Are heterotrophic</b>
<b>Have a cell wall made of cellulose</b>	<b>Have a cell wall made of chitin</b>
<b>Are always multicellular</b>	<b>Some are unicellular, others are multicellular.</b>

b) A spider is not an insect because it does not have the characteristics of insects: A spider, has four pairs of legs whereas insects have three pairs of legs. A spider has a body with two body parts (cephalothorax and abdomen) whereas insects have a body with three body parts (head, thorax and abdomen). The spider has no antennae whereas insects have one pair of antennae. The spider belongs to the group of arthropods called arachnids.

2) Answer:

Comparison between prokaryotes and Protocists

<b>Prokaryotes</b>	<b>Protocists</b>
<b>Are always unicellular</b>	<b>Some are unicellular (ex: paramecium, amoeba,...) others are multicellular( ex algae).</b>
<b>Are prokaryotic</b>	<b>Are eukaryotic</b>
<b>Have a cell wall composed of peptidoglycan</b>	<b>Some have a cell wall made of cellulose (ex: algae), others have no cell walls (ex:protozoa)</b>
<b>Are usually smaller</b>	<b>Are usually larger than prokaryotes</b>
<b>They have a circular DNA without proteins</b>	<b>They have a linear DNA which is associated with proteins to form chromatin</b>
<b>They do not have mitochondria and other membrane-bound organelles</b>	<b>They have mitochondria and other membrane bound organelles</b>
<b>They have small ribosomes</b>	<b>The have large ribosomes</b>

Some are autotrophic; others are heterotrophic.	Some are autotrophic; others are heterotrophic
---	--

3) Answer:

a) i) Carbon dioxide: C (in the mitochondrial matrix)

ii) Water: B (in the cristae of mitochondria)

b) Muscle cells contain large amounts of mitochondria in order to produce a high amount of energy necessary for the process of muscle contraction. The importance of mitochondria is to produce that energy in the form of ATP.

4) Answer:

Statement	Starch	Glycogen	Cellulose
Glycosidic bonds between monomers	√	√	√
Monomer is $\beta$ -glucose	X	X	√
Stored within chloroplasts	√	X	X
Stored in Muscle cells	X	√	X
Exist in two forms; branched and unbranched	√	√	X

5) Answer:

A solution of enzyme amylase was added to a solution of starch and this mixture was kept at 25°C. The starch was broken down by hydrolysis. Amylase catalyzes the breakdown of starch. When amylase reacts with starch, it cuts off the disaccharide maltose (two glucose molecules linked together). As the reaction progresses, less starch will be present and more sugar (maltose) will be present. The activity of amylase can be observed by using iodine because iodine reacts with starch to form a blue black colour. As amylase breaks down starch, less and less starch will be present and the colour of the solution (if iodine is added) will become lighter and lighter.

6) Answer:

Water weakens the attraction between ions of opposite charge because, having positive and negative charges itself, it attracts both. Moreover, once the ions have separated they are prevented from rejoining by water molecules clustering round each of them. Water is therefore a good solvent, ionic solids and polar molecules readily dissolving in it. This is of great importance because all the chemical reactions that take place in cells do so in aqueous solution. The polarity of water molecules also explains their association with each other. A positive hydrogen atom of one molecule may be attracted to the negative oxygen atom of another, leading to the formation of small clusters of water molecules. The hydrogen oxygen attraction holding the molecules together is known as hydrogen bonding.

7) Answer:

a) The mammalian circulatory system is described as closed because the blood is always kept inside the blood vessels; it does not mix with the interstitial fluid. It is also described as double closed circulatory system because the blood of mammals passes into the heart twice for a complete circuit.

b) Mature mammalian red blood cells have no nuclei. The advantage of this is that it allows the red blood cell to hold a big number of haemoglobin molecules which are involved in the transport of oxygen molecules (gives more room for haemoglobin molecules). The disadvantage of this is that the red blood cells cannot divide by mitosis as other cells. They are made in the bone marrow. Once they have performed their functions they are removed from the circulation by the spleen.

c) A wave of excitation spreads out from the sinoatrial node across both atria, causing their walls to contract. A layer of non-conductive tissue (atrioventricular septum) pass through a second group of cells called the atrioventricular node (AV node), which lies between the atria. The atrioventricular node, after a short delay (0.1-0.2 second), conveys a wave of excitation between the ventricles along a series of specialized muscle fibers called the Purkyne fibers through the atrioventricular septum to the base of the ventricle. The wave of excitation is released from the Purkyne tissue, causing the walls of the ventricles to contract quickly at the same time from the apex of the heart upwards.

8) Answer:

a) i) The expected diploid number for the sterile hybrid is  $2n = 63$ .

ii) This hybrid is sterile because it has an odd number of chromosomes in its cells. This hybrid cannot make a meiotic division in its cells because of the off number of chromosomes. Without meiosis the gametes cannot be produced. This is why this hybrid is sterile.

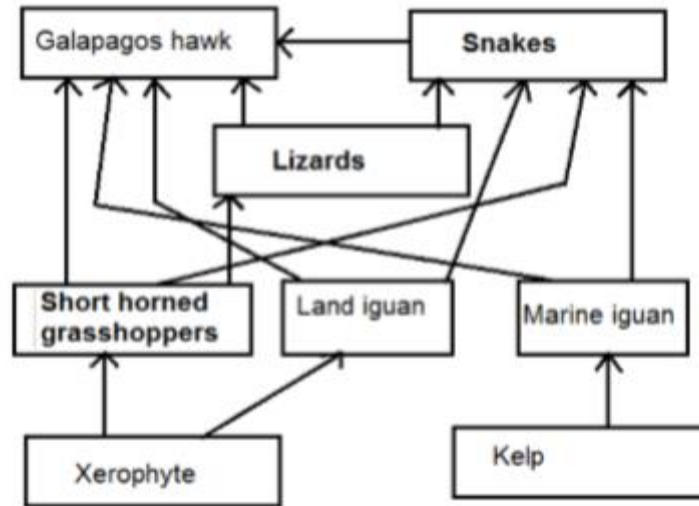
b) The doubling of chromosomes that may have produced *S. angelica* may be due to a mutation.

9) Answer:

a) The complete food web is represented below

i) The blank boxes are shown in the food web in bold character

ii) The arrows can also be seen on the food web below.



b) The producers are the kept and the xerophytes. Reason: the food webs start by producers which are autotrophic organisms. It is said in the paragraph that the kelp is a photosynthetic organism. This is why it is a producer or an organism that can make its own food. Xerophytes are plants and plants make their own food. It is also a producer. It is said in the paragraph that the xerophyte is grazed by land iguanas; so it is a producer.

10) Answer:

a) Nitrogen fixation is the conversion of nitrogen by bacteria to forms that can be used to synthesize nitrogenous organic compounds. Atmospheric nitrogen ( $N_2$ ) is converted to ammonia ( $NH_3$ ) by nitrogen-fixing bacteria in aquatic and soil environments. These organisms are nitrogen to synthesize the biological molecules they need to survive. Some nitrogen-fixing bacteria live in soil. Others live in the root nodules of legumes such as peas and beans. In aquatic ecosystems, some cyanobacteria are nitrogen fixing.

b) i) Ammonification

ii) The process of ammonification is done by decomposers. Decomposers return  $NH_3$  to the soil by decomposing solid waste and dead or decaying matter. Without these decomposers, there would be no imbalance in the composition of air. The process of ammonification which is also followed by denitrification helps to return back the nitrogen in the atmosphere as to help in the balance of the nitrogen cycle.

11) Answer:

a) Large and active animals need a special surface area for the exchange with the environment because they have a small surface area to volume ratio. When a cell grows its rate of metabolism increases at the same rate as its volume. This means that the rate of diffusion, which provides the materials for metabolism, must increase proportionally with a cell's growth. However, this can't happen because a cell's surface area increases at a much slower rate than its volume. Therefore, as cell grows and its surface to volume ratio decreases, it becomes increasingly difficult for the cell to obtain nutrients and expel wastes by diffusion. And at some point it simply becomes impossible. This is why large and active animals require a special surface area for the exchange with the environment.

b) The barrier diffusion must be as thin as possible because the rate of diffusion is directly proportional to the surface area and the concentration gradient and inversely proportional

to the thickness of the membrane. When the thickness of the membrane is decreased, the rate of diffusion increases.

12) Answer:

Mitochondria and chloroplasts contain small loops of DNA. They also contain ribosomes that are the same size as prokaryotic ribosomes. This suggests that mitochondria and ribosomes share the same origin; they all derive from prokaryotes that had been engulfed by large cells by the process of endosymbiosis. Endosymbiosis is a hypothesis for the origin of eukaryotes consisting of a sequence of endosymbiotic events in which mitochondria, chloroplasts, and perhaps other cellular structures were derived from small prokaryotes that had been engulfed by larger cells.

13) Answer:

a) The water potential of cell A:  $\Psi = \Psi_p + \Psi_s = -3 \text{ MPa} + (-10 \text{ MPa}) = -13 \text{ MPa}$ .

b) Arrows from C to B, C to A and B to A.

c) Physicists have assigned the value 0 ( $\Psi = 0 \text{ MPa}$ ) to the water potential of pure water. The addition of solutes to water lowers the water's potential (makes it more negative), just as the increase in pressure increases its potential (makes it more positive). Always water will move from an area of higher water potential to an area that has lower water potential.

14) Answer:

They are involved in the manufacture of proteins destined for being exported (presence of an abundance of Golgi apparatus) such as hormones (ex: testosterone). The abundant smooth endoplasmic reticulum suggests that these cells are involved in the synthesis of different products. The abundance of mitochondria suggests that all these processes that take place in these cells require much energy that must be generated by these mitochondria. The high amount of lysosomes suggests that these cells are also involved in the digestion of certain cell products and some macromolecules.

#### SECTION B: ATTEMPT ANY THREE QUESTIONS (30 marks)

15) Answer:

a) The functions of the autonomic nervous system in man

- Controls the heart beating
- Responsible for controlling the breathing rate
- Promotes the erection of genitalia
- Responsible for the fight and flight response
- Controls the activity of digestive organs such as the pancreas and the intestines
- Controls the release of glucose from the liver
- Controls the activity of salivary glands
- Controls the process of ejaculation and vaginal contractions....

b) Similarities between the autonomic nervous system and the endocrine system

- Both systems control involuntary activities
- Both involve transmission of a message which is triggered by a stimulus and produces a response

- Both systems use the same chemicals. Several chemicals such as norepinephrine and epinephrine function as both neurotransmitters and hormones.
- The target organs of a hormone are equivalent to nerve's effectors in the autonomic nervous system.
- Both systems provide means of communication within the body of an organism.
- Both systems involve a chemical transmission (hormones in the endocrine system and neurotransmitters in the nervous system).

16) Answer:

- Carbon dioxide is produced by respiring cells such as muscle cells.
- Carbon dioxide enters red blood cells in the tissue capillaries where it combines with water to form carbonic acid ( $\text{H}_2\text{CO}_3$ ). This reaction is catalyzed by the enzyme carbonic anhydrase (C.A), which is found in the red blood cells. Carbonic acid then dissociates to form bicarbonate ions ( $\text{HCO}_3^-$ ) and hydrogen ions ( $\text{H}^+$ ).
- This reaction also occurs outside the red blood cells, in the plasma, but is much slower due to the lack of carbonic anhydrase.
- The hydrogen ions, formed from the dissociated carbonic acid, combine with the haemoglobin in the red blood cell minimizing the change in pH.
- Bicarbonate ions diffuse out of the red blood cell into the plasma whilst chloride ions ( $\text{Cl}^-$ ) diffuse in to take their place. This is known as the chloride shift.
- When blood flows through the lungs, the relative partial pressure of  $\text{CO}_2$  out of the blood favour the diffusion of  $\text{CO}_2$  out of the blood. As  $\text{CO}_2$  diffuses into the alveoli, the amount of  $\text{CO}_2$  in the blood decreases. This decrease shifts the chemical equilibrium in favour of the conversion of  $\text{HCO}_3^-$  to  $\text{CO}_2$  enabling further diffusion of  $\text{CO}_2$  in the alveoli.
- Carbon dioxide diffuses into the alveolar space, from which it is expelled during exhalation.

17) Answer:

The functions of hormones are:

a) the pituitary hormones FSH and LH

- FSH (Follicle stimulating hormone) causes development of the follicles in the ovary, and stimulates the ovaries to produce oestrogen.
- LH (Luteinizing hormone) causes ovulation to occur. LH also stimulates the development of the corpus luteum from the empty Graafian follicle and stimulates the corpus luteum to produce progesterone.

b) The ovarian hormones oestrogen and progesterone

- **Oestrogen:** causes the rebuilding of the endometrium of the uterus after menstruation, and stimulates the pituitary gland to produce LH. It also inhibits the production of FSH.
- **Progesterone:** maintains the endometrium of the uterus in readiness to receive the blastocyst (young embryo), and inhibits the production of FSH from the pituitary gland.

**18) Answer:**

The life of eukaryotic cell is a cycle, known as the cell cycle. The cell cycle is a repeating series of cellular growth and division. The cell cycle has five phases:

The cell spends the majority of the cycle in the first three phases of the cycle, collectively known as interphase. After cytokinesis, two genetically identical daughter cells are formed.

- **The first growth (G1) phase:** the cell spends most of its life in the G1 phase. During this phase, a cell undergoes rapid growth and the cell performs its routine functions. If a cell is not dividing, the cell remains in this phase.
- **The synthesis (S) phase:** For two genetically identical daughter cells to be formed, the cell's DNA must be copied or replicated. When the DNA is replicated, both strands of the double helix are used as templates to produce two complementary strands. These new strands then hydrogen bond to the template strands and two double helices form.
- **The second growth (G2) phase** is a shorter growth period in which many organelles are reproduced or manufactured. Parts necessary for cell division are made during G2.
- **Mitosis** is the phase of nuclear division, in which one nucleus divides and becomes two nuclei.
- **After mitosis** there is cytokinesis, in which the cytoplasm divides in half producing two daughter cells, each containing a complete set of genetic material.

Stage	Events
Prophase	<ul style="list-style-type: none"> <li>• The chromosomes coil up and become visible as short rods. Each chromosome is really two chromatids (original DNA plus its copy) still attached at a region called the centromere.</li> <li>• The nuclear membrane disappears</li> <li>• The centrioles move toward opposite poles of the cell and organize the spindle fibers, which extend across the equator of the cell.</li> </ul>
Metaphase	<ul style="list-style-type: none"> <li>• The pairs of chromatids line up along the equator of the cell. The centromere of each pair is attached to a spindle fiber.</li> <li>• The centromere now divide</li> </ul>

Anaphase	<ul style="list-style-type: none"> <li>• Each chromatid is now considered a separate chromosome; there are two complete and separate sets.</li> <li>• The spindle fibers contract and pull the chromosomes, one set toward each pole of the cell.</li> </ul>
Telophase	<ul style="list-style-type: none"> <li>• The sets of chromosomes reach the poles of the cell and become indistinct as their DNA uncoils to form chromatin.</li> <li>• A nuclear membrane re-forms around each set of chromosomes.</li> </ul>
Cytokinesis	<ul style="list-style-type: none"> <li>• The cytoplasm divides; new cell membrane is formed.</li> </ul>

19) Answer:

a) Biodiversity is the number and variety of organisms found in a specific region.

b) The importance to maintain biodiversity

- Biodiversity allows us to live healthy and happy lives. It provides us with an array of foods and materials and it contributes to the economy. Without a diversity of pollinators, plants and soils, our supermarkets would have a low amount of food products.
- Most medical discoveries to cure diseases and lengthen life spans were made because of research into plants and animal biology and genetics. Every time a species goes extinct or genetic diversity is lost, we will never know whether research would have given us a new vaccine or drug.
- Biodiversity is a source of building materials for example making furniture from wood and animal skin and building houses from hard wood.
- Biodiversity is a source of fertile soils for example the remains of plants decompose to form humus. Humus makes the soil fertile and suitable for plantation. The roots of plants also hold the soil to prevent soil erosion caused by heavy rainfalls, especially in the hillside.
- Biodiversity allows for ecosystems to adjust to disturbances like extreme fires and flood.
- Genetic diversity prevents diseases and helps species adjust to changes in their environment.
- Simply for the wonder of it all. There are few things as beautiful and inspiring as the diversity of life that exists on Earth.