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## Life Sciences Olympiad Memo 2021

- 1 D Acrosome reaction: Oviduct (fallopian tube), Cortical reaction: Oviduct (fallopian tube).

Fertilization occurs when a sperm cell meets an egg cell in the fallopian tube. Acrosome reaction happens when a sperm cell reaches the egg cell and Cortical reaction occurs during fertilization when the egg cell prevents the fusion of multiple sperm in one egg, thus both reactions occurs in the fallopian tubes.

- 2 B I and II (The phosphate of one nucleotide is covalently bound (a bond in which one or more pairs of electrons are shared by two atoms) to the sugar of the next nucleotide.)  
III (Each base pair is formed from two complementary nucleotides (purine with pyrimidine) bound together by hydrogen bonds.)  
IV (Sugar is covalently bond to the nitrogenous base)

Thus I, II, IV is covalent bonds.

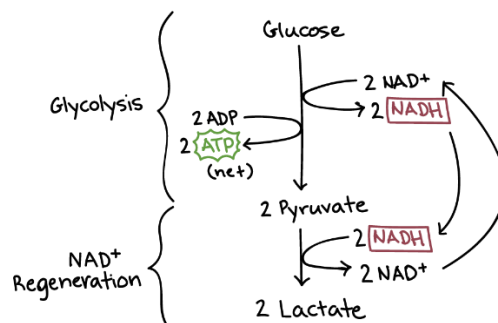
- 3 B In **splicing**, some sections of the RNA transcript **introns (50+100+90=240)** are removed, and the remaining sections **exons** are stuck back together.

750-240=510

- 4 D Figure D shows two chromosomes (replicated). Synapsis brings together homologous chromosomes, each composed of identical sister chromatids. Non-sister chromatids intertwine and break at the same location, then reattach to produce new combinations of alleles (Recombinants).

- 5 D Birds and reptiles (point P) has the least difference in amino acid sequences in the protein cytochrome C so we can make the assumption that they shared a most common ancestor.

- 6 B



ATP and Lactate are byproducts of lactic acid fermentation.

Muscle cells carry out lactic acid fermentation when they have too little oxygen for aerobic respiration to continue—for instance, when you've been exercising very hard. In **lactic acid fermentation**, NADH transfers its electrons directly to pyruvate, generating lactate as a by-product.

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- 7 D Concentration of lead nitrate is the independent variable. That is the factor that can be changed by the experimenter.
- 8 B/C Reliability in scientific investigation usually means the stability and repeatability of measures, or the ability of a test to produce the same results under the same conditions. ... Stability is determined by random and systematic errors of the measure and the way the measure is applied in a study
- 9 A Cell differentiation is how generic embryonic cells become specialized cells. This occurs through a process called gene expression. Gene expression is the specific combination of genes that are turned on or off (expressed or repressed), and this is what dictates how a cell functions. Gene expression occurs because of certain signals in your body, both inside and outside of your cells
- 10 C By behaving altruistically, an organism reduces its own fitness but boosts the fitness of its relatives—who have a greater than average chance of carrying the altruistic gene themselves. So the overall effect of the behaviour may be to increase the number of copies of the altruistic gene found in the next generation, and thus the incidence of the altruistic behaviour itself
- 11 D In eukaryotes, the citric acid cycle takes place in the matrix of the mitochondria, just like the conversion of pyruvate to acetyl CoA. The citric acid cycle is a closed loop; the last part of the pathway reforms the molecule used in the first step. After enough turns, all the carbon atoms from the acetyl group of acetyl CoA will be released as carbon dioxide.
- 12 C The first step is to calculate the total base pairs that will be present during the replication. Because the second strand starts after two-third has been copied it can be calculated as follow:  
 $16\,500 + (16\,500 \times \frac{2}{3}) = 27\,500$  nucleotides  
The second step is to determine how long it would take by using a rate of 50 nucleotides per second.  
 $27\,500 \div 50 = 550$  seconds
- 13 A H – Pulmonary Vein oxygenated blood to heart, D – Aorta send oxygenated blood to body, F – Vena Cava send deoxygenated from body to heart, I- Pulmonary Artery sends deoxygenated blood from heart to lungs.
- 14 A Watson and Crick discovered the double helix structure of DNA by means of an x-ray photo that was actually taken by Rosalind Franklin.
- 15 C The transfusable components that can be derived from donated blood are red cells, platelets, plasma, cryoprecipitate AHF, and granulocytes.
- 16 C The central dogma states that the pattern of information that occurs most frequently in our cells is:
- From existing DNA to make new DNA
  - From DNA to make new RNA (transcription)

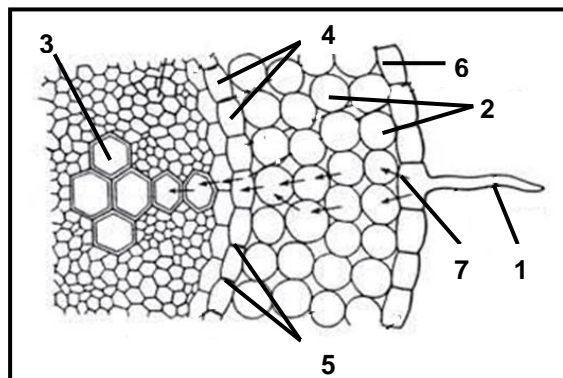
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- From RNA to make new proteins (translation).

- 17 B Ammonia contains nitrogen, which mixes with other elements in your body, including carbon, hydrogen, and oxygen, to form urea. Less intake of proteins by person A therefore less nitrogen.
- 18 B/C The H is expressed in hetero and homozygous condition and if one crosses  $I^A/i$  and  $I^B/I$  then Gilbert, Helen and their father's genotypes are present
- 19 A Individuals 1 and 2 being Dizygotic twins (they have the same father and mother) share 50% of the same genes. Individuals 4 and 5 only sharing the same mother and different father only share 25% of the same genetics.
- 20 B The major effects of insulin on muscle and adipose tissue are during Carbohydrate metabolism where it increases the rate of glucose transport across the cell membrane and it stimulates the rate of glycogen synthesis and decreases the rate of glycogen breakdown. During Lipid metabolism it decreases the rate of fatty acid oxidation in muscle and liver thus decrease in ketogenesis.
- 21 B Cnidaria and Platyhelmintha have a blind gut, Nematoda, Arthropoda and Annelida have through guts an Annelida is segmented.
- 22 A The Peeper and leopard mating period are more or less during the same time of the year between March and May.
- 23 A A required gene is identified, the second step will be to extract the plasmid and a required gene, the gene will be inserted in the plasmid and a modified cell is formed.
- 24 C The various wavelengths in sunlight are not all used equally in photosynthesis. Instead, photosynthetic organisms contain light-absorbing molecules called pigments that absorb only specific wavelengths of visible light, while reflecting others.
- 25 C Eukaryotic cells contain membrane-bound organelles such as the nucleus. Eukaryotic cells metabolises by means of the mitochondria. As seen in table the eukaryotic cells have differences in the type of covering of the cells and the production of food.
- 26 C Organisms of the same species interbreed to produce fertile offspring.
- 27 D Long sightedness is caused by a shorter eye ball or abnormally flat cornea. The focal point of nearby objects lies behind the retina.
- 28 B Life cycles are characterized by the timing of meiosis and the characteristics of the diploid and haploid generations. Embryonic development, (A), does not reveal either of these characteristics, nor does fertilization, (C). All gametes are unicellular, ruling out (D).

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- 29 D The haploid chromosomes number is created when homologous chromosomes separate during a first round of cell division, called meiosis I.
- 30 B The ear, limbs and genitalia are at risk in week 7.
- 31 D Abnormal sperm have difficulty reaching the egg in order to fertilize it. The larger the number of abnormal sperm the lower is the fertility of semen.  
A:  $40 \times 30\% = 12$  B:  $30 \times 65\% = 19,5$  C:  $20 \times 10\% = 2$  D:  $60 \times 70\% = 42$   
Thus D has the largest number of abnormal sperm.
- 32 C This is called haplodiploidy and males developed from haploid eggs and females from diploid eggs. There is a huge competition amongst the female to increase altruistic behavior.
- 33 B Introducing predatory fish to the carp will help to decrease the carp population without polluting the lake more. By inhibit recycling of nutrients accumulated in the substrate of the lake they carp population will not increase as rapidly. If more carp were to be released the carp population will increase more and the zooplankton will not be enough for all of the fish resulting in disaster.
- 34 B Green and Purple bacteria do not have chlorophyll like cyanobacteria. They contain bacteriochlorophyll, which is capable of absorbing shorter wavelengths of light than chlorophyll. As such, bacteria with bacteriochlorophyll tend to be found in deep aquatic zones where shorter wavelengths of light are able to penetrate.
- 35 D The mitochondria, endoplasmic reticulum, Golgi-complex, the lysosomal system have long been considered to be direct intracellular targets of irradiation.
- 36 C X is more evolved and thus on most present part of the cladogram. Y can be seen as the common ancestor of all the species.
- 37 B 1 - root hair, 2 – cortex, 3 – xylem, 4 – endodermis, 5 – Casparian strip, 6 - epidermis, 7– pathway of water and minerals

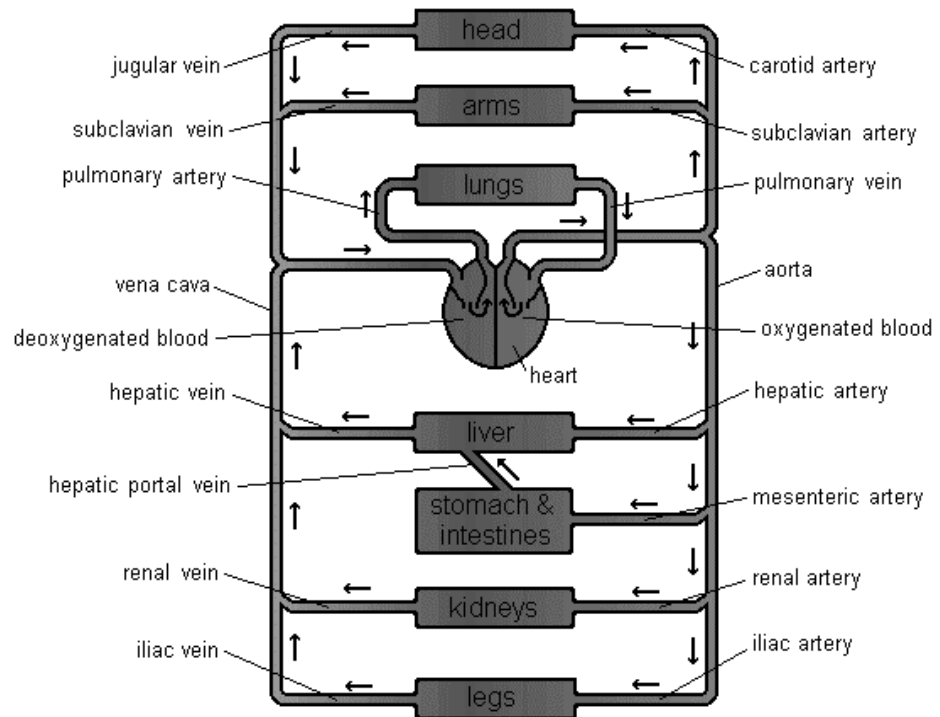


- 38 C Only judging by the body a clear assumption can be made that 5 is definitely Human. The lowest body temperatures can be allocated to the cold-blooded species such as the Carp and Bat, more accurate assumption can be made on evaluating max speed,

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thus number 1 is Carp and number 3 is a Bat. With this information alone the answer is C. The answer can be reached by other means.

39 B



40 B

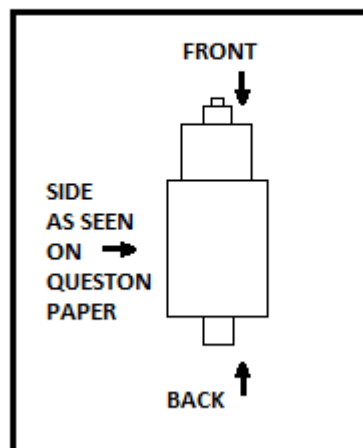
As we get older, we're less prone to moving and doing physical activities and that's probably the biggest contributor to your metabolic slowdown. The average human will see a 1-2% decrease in Basal Metabolic Rate every 10 years which makes us 50-70% of your total metabolism. Every decade after your turn 30, you will see a 1-2% decrease in BMR.

41 C

Susan has 41L water in her body. 45% of that water is not in cells, thus 18,45L. Of this 18,45L 83.3% can be found outside the blood vessels.  $18,45L \times 83,3\% = 15,37L$

42 D

**THE CROSS SECTION THROUGH THE DASHED LINE CAN BE SEEN AS THE TOP VIEW**



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- 43 D In evolutionary biology, convergent evolution is the process whereby organisms not closely related (not monophyletic), independently evolve similar traits as a result of having to adapt to similar environments or ecological niches.
- 44 A Plasmolysis is the loss of water by osmosis from a plant cell to the extent that the cytoplasm shrinks away from the cell wall. This happens when the cell is placed in a solution that has a higher solute concentration than that of the cell sap, i.e. it has a lower (more negative) water potential, since water always moves from an area of high water potential to an area of low water potential. **After plasmolysis the gap between the cell wall and the cell membrane in a plant cell is filled with hypertonic solution (which in this case is sugar)**
- 45 C The saliva present in mouth has acted upon starch to break down into sugars. So it does not show any colour in presence of iodine solution.
- 46 B At temperatures 25°C and 27°C it takes the pea weevil's eggs an average of 5 days hatching time which is the shortest hatching period. This means that moderate summers will promote highest population growth.
- 47 D Each pollen grain consists of two male gametes. Once they reach the ovary, one of the male gametes fuses with the female gamete and forms the zygote.
- The other male gamete fuses with the central cell which is diploid resulting in the formation of a triploid endosperm. Thus, the endosperm can be polyploid as well in certain cases. But, in gymnosperms, the endosperm is haploid.
- Y- one of the male gametes that fuses with Q- The diploid nucleus. Y + Q
- 48 B Mineral ions move from low concentration to high concentration against concentration gradient through active transport. Water moves by means of osmosis from a high concentration to a low concentration through a semi-permeable membrane until equilibrium is reached.
- 49 D Vampire bats form strong bonds with other members of the colony. A related unique adaptation of vampire bats is the sharing of food. A vampire bat can only survive about two days without a meal of blood, yet they cannot be guaranteed of finding food every night; this poses a problem, so when a bat fails to find food, it will often "beg" another bat for food. A "donor" bat may regurgitate a small amount of blood to sustain the other member of the colony. For equally familiar bats, the predictive capacity of reciprocity surpasses that of relatedness, this finding suggests that vampire bats are capable of preferentially aiding their relatives, but that they may benefit more from forming reciprocal, cooperative relationships with relatives and non-relatives alike
- 50 D The endoplasmic reticulum (ER) is involved in the synthesis of lipids and synthesis and transport of proteins. The Golgi apparatus modifies, sorts, and packages different substances for secretion out of the cell, or for use within the cell. Vesicles are also used as chemical reaction chambers
- 51 D Although sponges do not have organized tissue, they depend on specialized cells, such as choanocytes, porocytes, amoebocytes, and pinacocytes,

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for specialized functions within their bodies. The mesophyl acts as a type of endoskeleton, helping to maintain the tubular shape of sponges. All animals are multicellular but sponges are the only animals that have the cellular level of organisation

- 52 B Pine tree identification depends on the bark, trunk and how the pine tree needles are clustered. There are 115 different pine species world wide with a range of 2 to 5 needles
- 53 B A heterozygous red - eyed female cross with a red- eyed male will result into two red-eyed females 1 red -eyed male and 1 white- eyed male.
- 54 A Place a sample on the slide. Using a pipette, place a drop of water on the specimen. Then place on edge of the cover slip over the sample and carefully lower the cover slip into place using a toothpick or equivalent. This method will help prevent air bubbles from being trapped under the cover slip
- 55 A Genetically modified organisms are produced using scientific methods that include recombinant DNA technology. GMOs produced through genetic technologies have become a part of everyday life, entering into society through agriculture, medicine, research, and environmental management.
- 56 A Their feet are slender, for they don't have to do much more than just hold onto their perch.
- 57 B Photosynthesis require  $O_2$  to take place. Products of photosynthesis is  $CO_2$ , and food for the plant. Therefor the decrease.
- 58 B The rate of digestion increased per unit time, there for the upwards movement of the graph.
- 59 C For the experiment to prove the hypothesis we need to keep the meet controlled. For this reason, both jars need to have meat, and then allow flies to come close to it or not.
- 60 B It is easier for water molecules to enter the cell because they are much smaller to enter through the membrane
- 61 B Finches have to adapt to the different food sources which enable them to eat the food available to survive.
- 62 C This is because, as a natural mechanism to defend themselves, the larger fish would become averse to all cleaner fish and cleaner-fish-looking fishes because it is difficult to differentiate between the beneficial and attacker fishes. Ultimately the cleaner fish would decrease and the larger fish would become more infested with parasites on their bodies.

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- 63 B Jogging burn 3 times more calories than walking. For this reason the jogging should have a steeper gradient than the walking, even though the walking is over a longer period of time, it still burns slower, therefor the less steep slope.
- 64 B The reliability depends on the (a) repeats and (b) sample size. The more the repeats and the larger the sample size the more likely the same or similar results hence the more reliable.
- 65 A Segmented worms are "annelids", like earthworms. Centipedes belong to the class chilopoda, along with other centipedes. They are also part of the phylum arthropoda, which is an entirely separate phylum from segmented worms.
- 66 C Nematodes have a very simple but complete digestive system that is successful with digestion.
- 67 B The integument and nucellus are diploid and will stay diploid after fertilization. The cells of archegonia are haploid and and give rise to haploid ovums.
- 68 A Taxonomy is about classifying living organisms, organizing them according to their similarities.
- 69 C When water levels is blood becomes low ADH is released in the blood. It stimulates the body to store water.
- 70 D Ligation of necessary centromeric sequences for mitotic stability Ligation of Autonomously Replicating Sequences (ARS) providing an origin of replication to undergo mitotic replication. This allows the plasmid to replicate extra chromosomally, but renders the plasmid highly mitotically unstable, and easily lost without the centromeric sequences. Ligation of artificial telomeric sequences to convert circular plasmid into a linear piece of DNA
- 71 A Mature red blood cell (RBCs) lack DNA,nucleus and other metabolic systems needed for mitosis because it provides them a bi-concave shape to carry more oxygen and easily pass through capillaries where they have to move in a single row. Therefore if a cell lacks DNA,nucleus and other important metabolic system for cell division it will definitely not divide
- 72 A Ovum of surrogate mother is used where the nucleus is removed. The animal that will be cloned will donate a somatic cell with its ovum removed. The nucleus is put into the ovum of the surrogate mother.
- 73 D Mutualism, indicates a positive relationship, commensalism a neutral relationship and parasitism a negative relationship.
- 74 A During cellular respiration, a glucose molecule is gradually broken down into carbon dioxide and water. Carbon dioxide colour the bromothymol to yellow
- 75 A The haploid chromosome shows a combination of the diploid cells which indicates that crossing over has taken place.



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- 76 A The gametes are the ones that are going to fuse with each other to represent all the genes from both parents.
- 77 B Blood flow is responsible for carrying oxygen through the body. When blood flow is decreasing, less oxygen will be transported.
- 78 A Amino acid is the only compound with nitrogen.
- 79 D Fleas are very small and plenty of them can feed on one rabbit. In this case option D is the correct choice
- 80 A Pepsin is active in an acidic environment and it breaks down proteins into smaller units(amino acids)
- 81 C In this unique type of inheritance, the mitochondria contain their own DNA. Only mitochondrial disorders caused by mutations in the mitochondrial DNA are exclusively inherited from mothers. If this is the way a mitochondrial disease was inherited, there is a 100% chance that each child in the family will inherit a mitochondrial disease.

- 82 B If nondisjunction occurs during anaphase II of meiosis II, it means that at least one pair of sister chromatids did not separate. In this scenario, two cells will have the normal haploid number of chromosomes. Additionally, one cell will have an extra chromosome ( $n + 1$ ) and one will be missing a chromosome ( $n - 1$ ).

- 83 B Daughters inherit one recessive colour blind allele from their mother and one dominant normal vision allele from their father. the dominant allele masks the recessive allele hence None will be colour blind
- Symbol: D-dwarf d-normal B-normal b-colorblind (dominant is capitalized)
- Father ("the man") : D? BB
- Mother ("the woman") : D? bb (D? for achondroplastic and bb for recessive color blindness)
- Grandfather—Father ("the man")'s father—dd  
Grandfather—Father ("the woman")'s father —dd
- As shown above, the father of man i.e. grandfather has normal height (dd). He will contribute one allele to his offspring (man), so one allele of man must be d. Hence, the man genotype will be Dd BB
- Same rationale is applicable for the woman, so her genotype will be Dd bb.
- Now, the cross between man and woman will result in following offspring:  
Dd BB X Dd bb No daughter will be color blind.

Db	db
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[Type here]

DB	DDBb	DdBb
dB	DdBb	ddBb

84

B

All sons will inherit one recessive colour blind allele from their mother who is homozygous recessive and all of the sons will become colour blind because they inherit only Y chromosome from their father

Symbol: D-dwarf d-normal B-normal b-colorblind (dominant is capitalized)

Father ("the man") : D? BB

Mother ("the woman") : D? bb (D? for achondroplastic and bb for recessive color blindness)

Grandfather—Father ("the man")'s father—dd

Grandfather—Father ("the woman")'s father—dd

As shown above, the father of man i.e. grandfather has normal height (dd). He will contribute one allele to his offspring (man), so one allele of man must be d. Hence, the man genotype will be Dd BB

Same rationale is applicable for the woman, so her genotype will be Dd bb.

Now, the cross between man and woman will result in following offspring:

Dd BB X Dd bb

	Db	db
DB	DDBb	DdBb
dB	DdBb	ddBb

Proportion of sons with color-blindness and normal height (ddbb) is zero.

85

B

Quinine is a medication used to treat malaria and babesiosis. This includes the treatment of malaria due to Plasmodium falciparum that is resistant to chloroquine when artesunate is not available.

86

D

For carbon to convert from organic to inorganic form the plant needs to decompose. During decomposing Carbon dioxide forms which is released into the air. Carbon dioxide is an inorganic form of carbon, due to the CO<sub>2</sub> composition.

87

D

For photosynthesis to take place the plant needs Carbon dioxide and water to produce nutrients for the plant and sugar.

For this reason, there is no other answer. All the other is not relevant

88

A

The diaphragm contracts to increase the lung volume. Air then flows into the lungs which inflated the lungs.

89

B

If the temperature of the mixture was raised the mixed will become solid, thus the only way the mixture could become clear is for the pH of the mixture to change. This could be due to many reasons.

Stirring the mixture will have no effect on the colour

Iodine will change the colour and will not remove the colour

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- 90      A      For the rate of a reaction to increase the molecules need to move faster, for this to be possible the temperature needs to increase.  
pH will cause a reaction, due to the acid or base which is added. Due to this the temperature will increase which will increase the reaction rate.
- 91      A      Hormone production and release are primarily controlled by negative feedback. In negative feedback systems, a stimulus causes the release of a substance whose effects then inhibit further release. In this way, the concentration of hormones in blood is maintained within a narrow range
- 92      A      The plant flourished under shaded areas with enough fertiliser, thus if you provide your plant the right fertiliser in the right pot it will grow.
- 93      B      Plants need sunlight to produce needed nutrients, thus the transparency provides the plant with the needed sunlight
- 94      B      During the elongation of plant cells, the nucleus divides into two. The elongation is the formation of new cells to promote the growth of the plant. Thus the nucleolus is visible during the division of the cell.
- 95      D      Blood groups can be categorize, and breathing forms a continuous spectrum ranging from one extreme to another.
- 96      D      Nitrogen is a component of amino acid. Amino acid is the building blocks for proteins. Proteins comprise not only structural components such as muscle, tissue and organs, but also enzymes and hormones essential for the functioning of all living things.
- 97      B      The comparison cell can be found in the phloem of flowering plants. It can be closely found to sieve elements. It is unsure what the function of comparison cells is. Excretory tissue is tissue which is used to eliminate waste in the plant structure. Can mostly be found in leaves.
- 98      A      A not C due to the fact that is more important to acknowledge that we are working with the bacteria and what effect the antibiotics has on it, thus species A is less resilient to the antibiotics.
- 99      C      Carbohydrates is the main source of energy. Fats are a reserve energy source and lastly proteins then proteins act as a source of energy after the other organic compounds have been broken down for energy.
- 100     D      Cutting the apical bud, which contains the auxins, will cause the production of auxins lower down in the stem and then stimulate the growth of lateral branches and therefor hedge will grow thicker.