



Units 3 and 4 Biology

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Section A – Multiple-choice questions

Question 1

The correct answer is C. The cell would crenate because the solution would be hypertonic to the cell, so water would flow out of it via osmosis in order to decrease the concentration gradient.

Question 2

The correct answer is D. Enzymes are three dimensional tertiary proteins, which means they are globular, not fibrous.

Question 3

The correct answer is C. There would be 27 percent thymine in the cell as well as 27 percent adenine, due to base pairing rules. Thus, 54 percent of the nitrogenous base material would be adenine and thymine, leaving 46 percent for cytosine and guanine. Due to base pairing rules, this means that 23 percent of the DNA would have to be guanine.

Question 4

The correct answer is B. Proteins are synthesised at the rough endoplasmic reticulum in eukaryotic cells.

Question 5

The correct answer is A. Organelle A is a mitochondrion, responsible for cellular respiration, which is the conversion of 3 carbon glucose into useable ATP molecules.

Question 6

The correct answer is A. The final acceptor molecule in the electron transport chain is oxygen.

Question 7

The correct answer is D. The outputs of the light dependent phase of photosynthesis (the splitting of water) are 2 ATP, Hydrogen ions which are bound to acceptor molecules, 'loading them', and oxygen.

Question 8

The correct answer is A. The thylakoid membrane in the grana contains embedded chlorophyll molecules, which absorb sunlight in the light dependent phase.

Question 9

The correct answer is C. Substrate B would have nothing to bind to and would thus build up in the cell. As a consequence, enzyme X would not be produced and so the cell would continue to initiate the process, resulting in a build-up of enzyme Y.

Question 10

The correct answer is B.

Question 11

The correct answer is D. Receiving anti venom (antibodies) from a horse is means the affected organism is not creating antibodies to combat the antigen, and thus is an example of passive immunity.

Question 12

The correct answer is B. The desert mouse would need to conserve water, so would have a lengthened loop of Henle in the nephrons of its kidneys to allow for maximum water reabsorption from waste. Consequently, the mouse would have very concentrated urine.

Question 13

The correct answer is A. Fish produce the highly toxic ammonia as waste, as in nature it is diluted in the large bodies of water they inhabit. Within the confines of a fish tank, the levels of ammonia become too concentrated, and unless proper filtration and nitrogen fixation occur, the fish will die.

Question 14

The correct answer is C.

Question 15

The correct answer is A. The electron transport chain generally produces 32 ATP, but in certain cells with a high energy requirement (e.g. heart muscle cells) 34 ATP can be produced. The reason D is wrong is that when it is written as 32-34 ATP this implies that 33 ATP can be produced, which is impossible.

Question 16

The correct answer is C. Fermentation in plants produces ethanol and carbon dioxide, and occurs when oxygen is not available to undergo aerobic respiration.

Question 17

The correct answer is B. 2 pyruvate (or pyruvic acid) molecules, broken down from glucose in glycolysis enter the mitochondrion to initiate cellular respiration.

Question 18

The correct answer is B. When a large enough difference is caused by depolarisation along the axon, an action potential is generated and the nervous impulse is thus sent along the neuron and to the synapse, where it will be carried by neurotransmitters to the following neuron's dendrites.

Question 19

The correct answer is A. Schwann cells can be found on the axon, as part of the myelin sheath.

Question 20

The correct answer is C.

Question 21

The correct answer is C. The band represented by Y is on the sister chromatid to the chromatid with the band represented by X, and thus would be identical to X.

Question 22

The correct answer is B. Eukaryotic cells have linear chromosomes present in the nucleus, a membrane bound organelle. Prokaryotic cells do not have membrane bound organelles, so their DNA is free in the cell. Eukaryotic cells do have DNA in their mitochondria and chloroplasts, but this DNA is in the form of a prokaryotic circular chromosome or plasmids, not linear chromosomes.

Question 23

The correct answer is D. Apoptosis is programmed cell death.

Question 24

The correct answer is C. The trait does not skip generations, so it is not recessive. Individuals III2 and III3 are affected, as is their father, indicating the X-linked dominant pattern of inheritance, where affected males pass the affected dominant allele onto all female offspring.

Question 25

The correct answer is B. The females would have received one normal X chromosome from their mother and one CHILD X chromosome from their father.

Question 27

The correct answer is B. In the case of a missense mutation, one allele is changed, (a substitution) resulting in a different amino acid being coded for.

Question 27

The correct answer is D.

Question 28

The correct answer is B. The genotype influences the phenotype as there is complete dominance of white to blue. However, the phenotype is also influenced by environment, and pink flowers are seen with increasing pH.

Question 29

The correct answer is C. DNA helicase separates double stranded DNA for replication during the S phase of the cell cycle.

Question 30

The correct answer is B. The fragments in lane one have moved a smaller distance across the gel than those in lane 8, so lane one must contain the larger fragments.

Question 31

The correct answer is C. Transgenic organisms rely on the insertion of foreign DNA into the embryo, not the somatic tissue. This means that the gene products of the foreign DNA will have the potential to be expressed by all resulting cells of the embryo.

Question 32

The correct answer is A. The range of phenotypic variation seen is due to continuous (polygenic) inheritance.

Question 33

The correct answer is D. Carbon – 14, which decays to Nitrogen – 14 has a half-life of 5,578 years and can determine the age of deposits between 100 and 50,000 years old.

Question 34

The correct answer is B. The other examples are simply evidence of structural, not cultural evolution.

Question 35

The correct answer is B. *Homo Neanderthalensis* had a larger brain case than modern humans, but did not have such a large frontal lobe (the region of the brain involved in problem-solving) comparative to the rest of the brain, compared with modern humans.

Question 36

The correct answer is A. The rest are relative measures.

Question 37

The correct answer is D. Opposable thumbs seen in both apes and humans are homologous features and are thus indicative of divergent evolution.

Question 38

The correct answer is B. This is an example of homologous features and suggests divergent evolution.

Question 39

The correct answer is C.

Question 40

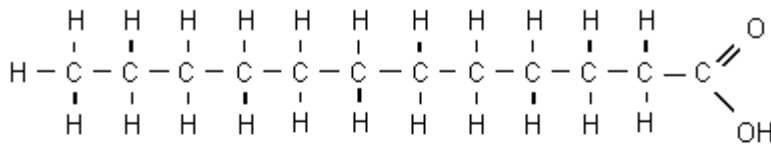
The correct answer is B. The rock has undergone two half-lives, as it contains a quarter of the original ^{235}U . This places it at 1.4 billion years, as one half life is measured at 700 million years.

Section B – Short-answer questions

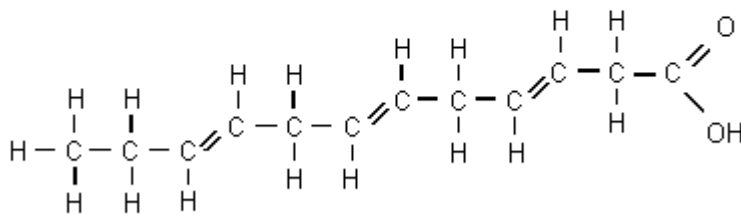
Marks allocated are indicated by a number in square brackets, for example, [1] indicates that the line is worth one mark.

Question 1a

Monounsaturated fats and polyunsaturated fats contain double bonds in their fatty acid chains.



Saturated Fatty Acid



Unsaturated Fatty Acid

[1]

A diagram was not necessary to achieve the mark, but aided in students' explanations of the differences.

Health experts encourage us to eat them because our body has to use energy in breaking the double bonds in digestion, thus they increase our energy output and reduce the likelihood that the acids will be unused and converted to adipose tissue [1]

Question 1b

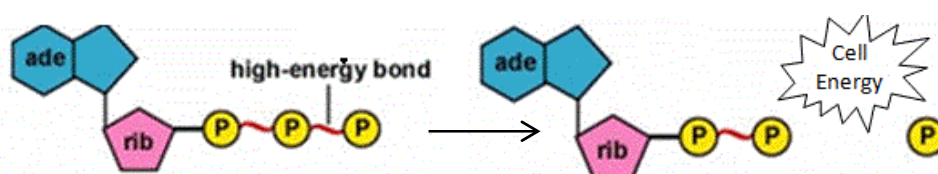
A potato and a liver are similar in that they are both storage organs of complex carbohydrates [1]. In animals, this is glycogen, and in plants (i.e., a potato plant) this is starch [1].

Question 1c

A monosaccharide is a simple sugar, made up of one ring-structured unit, such as glucose [1]. A polysaccharide contains many monosaccharides repeating in a chain, such as cellulose [1].

Question 1d

The bond joining the third phosphate group to the adenine and two phosphates is broken, releasing energy [1]. 1 mark for a suitable diagram, such as the example below:



Question 2a

An enzyme is a three dimensional tertiary protein that works as a biological catalyst [1] to speed up reactions in the body to a rate that will sustain life [1]

Question 2b

Various answers accepted, however each would gain three marks for discussing:

- A hypothesis;
- A method, including repetition, variables and controls; and
- Results that would support or not support the initial hypothesis

Question 2c

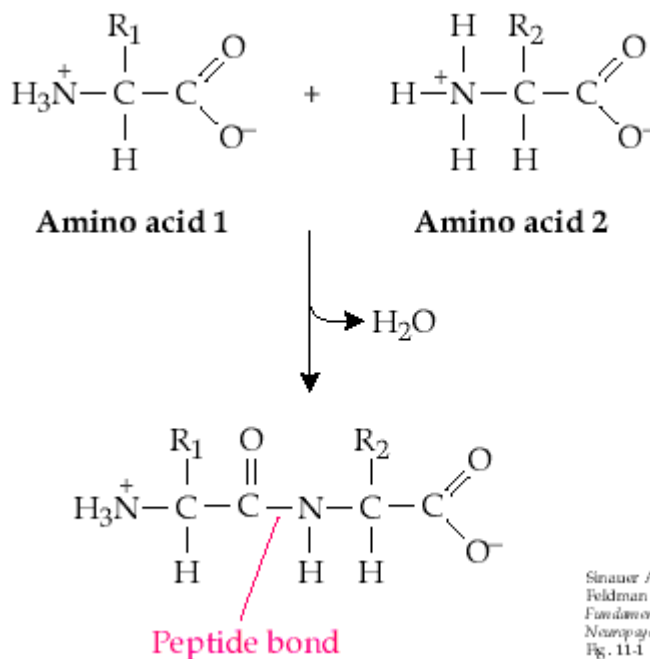
Mythase may exist in the stomach where the pH is low [1]. A mark is given for any acidic environment in the digestive system.

Question 2d

In an acidic environment, the three-dimensional structure would be stable [1]. However, when the pH increases, hydrogen bonds and other attractive forces holding together this shape would degrade, and the enzyme would denature [1].

Question 2e

Two amino acids join to form a peptide bond when there is a condensation reaction [1] between the amino and the carboxyl groups. One mark for a suitable diagram, an example is below:

**Question 3a**

There are 64 possible anticodons, and only 20 available amino acids in humans. Thus, there is some redundancy in the genetic code [1].

Question 3b

Due to two anticodons being given for phenylalanine and stop anticodons, various answers are possible. An example is below. A mark is given for correct DNA sequence of the 5 amino acids along with the stop codon.

TAC-AAA-TGG-ACT-AGA-ATT

Question 3c

Messenger RNA is synthesised during transcription. The template DNA strand is unwound and RNA polymerase bonds to the promoter area, initiating RNA synthesis [1]. When a stop sequence is reached, the RNA synthesis ceases and the messenger RNA is modified and sent out of the nucleus via the nuclear pores [1].

Question 4a

A reflex arc occurs when a stimulus response model occurs without the inclusion of the central processing unit (CPU) [1]. An example is the knee jerk reaction, where the sensory neurons detect the tapping below the kneecap and send a message straight to muscle effector neurons, bypassing the use of interneurons.

Question 4b

The extra time that is saved by avoiding sending a message to the brain is used to avoid the danger of the boiling water, saving Christina the possibility of getting burnt [1].

Question 4c

One mark is received for each row if both boxes are filled out correctly.

	Part of the central nervous system, peripheral nervous system, or both?	Brief description of function
Thermoreceptors on the skin	Peripheral	Detect levels of heat on the skin and send a message to the control centre
Hypothalamus	Central	The control centre for various involuntary homeostatic processes, located at the base of the brain

[1] for each complete row.

Question 5a

An autoimmune disease occurs when the body's immune system recognises certain body cells as being "non-self" and attacks them [1].

Question 5b

5 minutes after irradiation the healthy cells are at their peak of cytochrome c concentration, whereas the MAA cells are at their lowest concentration. After irradiation the healthy cells have been induced to undergo apoptosis, beginning with the release of cytochrome c, and therefore there is a high concentration of cyt c in the cytoplasm [1]. The MAA cells on the other hand, have begun undergoing apoptosis before the UV radiation was applied, and so cytochrome c will have dissipated into the extracellular matrix [1].

Question 5c

5 minutes after irradiation the healthy cells are beginning to undergo apoptosis, and so there is a high concentration of cytoplasmic cytochrome c [1]. After apoptosis has occurred and the cell has been broken down (20 minutes later), the cytochrome c has dispersed out of the cell [1].

Question 5d

A virus will inject its nucleic acid into the host cell, and the machinery of the host cell will be used in order to replicate the nucleic acid and protein components of the virus [1]. After multiple new viruses have assembled in the host cell, it will be lysed so the viruses may disperse and infect other cells [1].

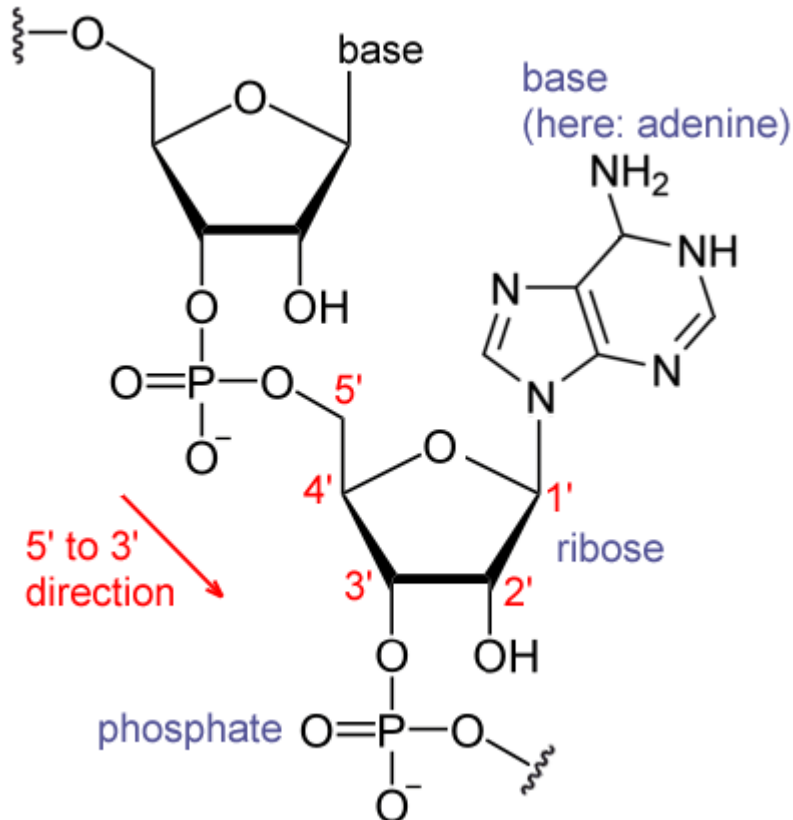
Question 5e

A retrovirus uses RNA, instead of DNA, as its nucleic acid [1].

Question 5f

The MAA-inducing virus would infect T cells [1].

The information at the beginning of the question specified that T cells induce the muscle cells to undergo cytochrome c release.

Question 6a

Students must show correct sugar-phosphate backbone, [1] also indicating a direction to each end of the strand. [1]

Phosphates, sugars and bases do not have to be drawn to such detail. Base must be shown to be connected to the sugar, not phosphate. [1]

Question 6b i

The ingredients for PCR are: DNA polymerase (*Taq* polymerase), dNTPs (nucleotides), sequence of DNA to be amplified and Primers.

Students must mention at least two ingredients in order to obtain the mark.

Question 6b ii

The basic steps for PCR are:

Heating: Heating the strands to 95 degrees Celsius to separate (denature) it into its two complementary strands. [1]

Annealing: The DNA is cooled to 72 degrees Celsius to allow the primers to anneal to the single stranded DNA. [1]

Extending: The DNA is further cooled to allow extension the primers to promote the replication process, whereby the DNA polymerase adds the free nucleotides. The process is then repeated. [1]

Question 6b iii

The second DNA strand, the one containing 60% guanine and cytosine pairs [1] will require a greater temperature to be denatured (separated). This is because there are 3 hydrogen bonds between guanine and cytosine pairs and only two between adenine and thymine pairs, meaning that a greater temperature is needed to break all of these hydrogen bonds in DNA with a higher proportion of guanine to cytosine pairs. [1]

Question 6c

In DNA replication, synthesis of the new strand occurs in a 5' → 3' direction. As such, the leading strand is the one on which the new strand can be synthesised continuously. [1] The complementary strand is the lagging strand, which must be synthesised in fragments [1] (Okazaki fragments) which are then joined together by DNA ligase.

Question 7a

Transfer RNA (tRNA) [1] OR Ribosomal RNA (rRNA). [1]

Question 7b

tRNA – to carry specific amino acids to the ribosome for protein synthesis [1]

OR

rRNA – to provide a site on the ribosome for protein synthesis [1]

Question 7c

- Introns must be spliced out [1]
- Poly – A tails must be added [1]
- Methyl caps must be added [1]

Question 8a i

Green (G) and spotted (S) are dominant to yellow (g) and without spots (s).

Frog One: GGss

Frog Two: ggSS

F1 Frog: GgSs

[1] mark awarded if all genotypes are correct and green and spotted are identified as being dominant (different letters may be used for alleles).

Question 8a ii

The genes are assorting independently [1]. We know this because there is a 9:3:3:1 phenotypic ratio in the F2 offspring. [1]

Question 8a iii

We would expect a 3:1 green spotted: yellow unspotted phenotypic ratio with recombinants if the genes were linked. [1]

Question 8b

Co-dominance is where two dominant alleles of a gene are equally expressed, such as red and white coat colour in roan cattle. [1] Incomplete dominance is where the phenotype is a 'mix' of two dominant alleles, such as pink flowers that have an allele for red and for white colour. [1]

Question 8c

There would be a 2:1 dominant:recessive trait phenotypic ratio. [1] This is because 1/3 of the offspring that would display the dominant trait are dead as they are homozygous dominant. [1] mark awarded for punnet square showing this.

	A	a
A	AA	Aa
a	Aa	aa

Germline mutations are mutations that occur in the germ cells, that is, the gametes (egg and sperm). [1]

Question 9a

Germline mutations are mutations in the germline cells that divide to produce gametes. [1]

Question 9b

A woman with Turner 's syndrome would not be able to reproduce [1]. Her single sex chromosome would not be able to pair with another sex chromosome at meiosis to form gametes. [1]

Question 9c

Non-disjunction has occurred [1] at anaphase 1 of meiosis [1]

Question 10a

Simply relying on an unpleasant taste means that predators have to learn not to eat these organisms – thus some get half-eaten in the process! [1]

Question 10b i

The non-poisonous species detract predators who believe they are poisonous, without having to expend the energy necessary to produce the poison, therefore increasing their chance of survival. [1]

Question 10b ii

Originally there existed variation in the brightness of the *C. calensis* population. [1] Predators acted as a selection pressure, killing and eating the less brightly coloured caterpillars. [1] This meant that a higher number of brightly coloured caterpillars were surviving, reproducing, and passing the genes for bright colours on to their offspring. [1] Over time, the population became more brightly coloured.

Question 10c

Various answers accepted.

An example of genetic drift that could lead to speciation is the founder effect. [1] If a small population is isolated from a parent population, over time different selecting pressures and different underlying allele frequencies in the two populations can reproductively isolate the two populations. [1]

Question 10d

They must be able to interbreed and produce viable offspring. [1]