

# Units 3 and 4 Biology

## Practice Exam Solutions

Stop!

Don't look at these solutions until you have attempted the exam.

Any questions?

Check the Engage website for updated solutions, then email [practiceexams@ee.org.au](mailto:practiceexams@ee.org.au).

## 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. When an enzyme's environment has a temperature outside its optimum range, the enzyme's ability to catalyse the reaction is impaired. If the temperature exceeds the optimum range then the enzyme's active site gets permanently denatured and can no longer catalyse the reaction. However, if the enzyme's environmental temperature is less than optimum the enzyme is not denatured and can in effect still function. However, its ability to catalyse the reaction is hindered and hence the reaction occurs at a slower rate than if the enzyme was operating under optimal conditions.

### 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. This is because the rough endoplasmic reticulum is composed of ribosomes where protein synthesis occurs.

### Question 5

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

### 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 of photosynthesis.

### 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, with failure to execute its inhibitory effects on enzyme Y resulting in a build-up of enzyme Y.

### Question 10

The correct answer is B. An allosteric site on an enzyme is a site in which when something else binds to it, changes the active site of the enzyme with this site.

### Question 11

The correct answer is D. Receiving anti venom (antibodies) from a horse 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 D. The three steps involved in signal transduction are respectively reception, transduction and induction. Reception involves the binding of a signalling molecule to a specific receptor. Transduction is when a second messenger is formed in or released into the cytosol (the second messenger amplifies the stimulus and initiates the cells response). Induction is the activation of cellular processes.

**Question 13**

The correct answer is D. Immunoglobins is another word for antibodies which is involved alongside B lymphocytes, in the specific humoral immunity response in the body's third line of defence.

**Question 14**

The correct answer is C. The smooth endoplasmic reticulum does not possess ribosomes like the rough endoplasmic reticulum does and hence cannot produce proteins. However, the smooth endoplasmic reticulum is still involved in a type of synthesis but it is of the synthesis of lipids.

**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. The entire outcome of aerobic cellular respiration is 36 or 38 ATP, 32 or 34 of which is produced in the electron transport chain and 2 ATP produced in both glycolysis and the Krebs' cycle.

**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. In contrast when anaerobic respiration occurs in animals lactic acid and carbon dioxide are produced.

**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 C. In response to have higher blood sugar levels the negative feedback response under goes a number of actions to reduce the blood sugar levels to help achieve blood sugar levels to homeostatic levels. The other options A,B and D are all examples of positive feedback.

**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. B lymphocytes are produced and mature in the bone marrow.

**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. Note that sister chromatids possess identical alleles in ordinary cases, however homologous chromosomes may differ in terms of the alleles they possess.

**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 allele responsible for the affected dominant trait 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 26**

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, that results in a slight alteration of the active site of the 3-beta-hydroxy sterol dehydrogenase that is responsible for the disease.

**Question 27**

The correct answer is D. This principle states that when two or more characteristics are inherited (as alleles) different alleles from each homologous chromosome assort independently during gamete production (meiosis) giving genotypes an equal opportunity of occurring together.

**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 during DNA replication that occurs 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 as evident by the continuous distribution graph.

**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 as the bone structures have similar structure.

**Question 39**

The correct answer is C. DNA ligase can be thought of as the glue that joins the Okazaki fragments on the lagging strand so that the strand is continuous like the leading strand.

**Question 40**

The correct answer is B. The rock has undergone two half-lives, as it contains a quarter of the original  $^{235}\text{U}$ . 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 [1].

### Question 1a

Condensation reaction. [1]

### Question 1b

The subunits of a triglyceride (fatty acids and glycerol) combine together releasing three molecules of water (one for each fatty acid). [1]

### Question 1c

Phospholipid. [1]

### Question 1d

	Active/ Passive	Process used
Glucose	Active OR Passive	Active transport OR Facilitated diffusion
Water	Passive	Osmosis.

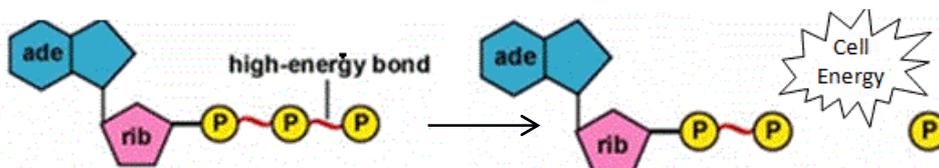
### Question 2a

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

As the question did not explicitly state it, examples of mono and poly saccharides are not required to obtain full marks for question. However examples can be used to demonstrate you know the difference to aid your explanation.

### Question 2b

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



### Question 3a

An enzyme is a three dimensional tertiary protein that works as a biological catalyst [1] to speed up reactions in the body without being used up. [1]

The key to this question was to look at the marking scheme as it is a definition worth [2], 2 key points of enzymes needed to be included in the definition.

**Question 3b**

A range of responses are acceptable.

[1] for describing a suitable method including setup and how enzyme activity is measured. Students must include equal volumes of solution in the test tubes to gain the mark to show they understand the importance of control.

[1] for mentioning the control of additional variables other than volume (ie. temperature) and/or repetition to improve accuracy of experiment.

If students say hypothesis is proven they cannot gain the mark, a hypothesis can only be supported.

Below is an example of a high-scoring response:

*Hypothesis: Mythase will be most effective at the low pH of 2. [1]*

*Method: Set up each test tube with 4 mL (or any suitable volume) of a solution at different pH (2,5,7,9,12) and label each test tube. Add equal portions of substrate X into each test tube. Add 4ml of Mythase in each of the test tubes. Control all variables, such as temperature. Measure the activity from each test tube by measuring the height of bubbles produced or counting the number of bubbles produced (from the gaseous product Z) for 30 seconds for each test tube. Repeat experiment to improve accuracy.*

*Results to support/negate hypothesis: If the test tube containing the pH 2 solution produces the most gaseous Z bubbles per 30 seconds, then the hypothesis is supported. [1]*

**Question 4a**

The genetic code is known as being redundant or degenerate, this means that more than one codon can code for a particular amino acid. [1]

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

**Question 4b**

Due to two anticodons being given for phenylalanine and stop anticodons, various answers are possible. As AAA or AAG can be used for Phe TGG or GTG can be used for Gly and ATT or ATC can be used for a stop codon. 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 4c**

Messenger RNA is synthesised during transcription. The template DNA strand is copied during transcription and RNA polymerase joins complementary nucleotides. [1] When a stop sequence is reached, the RNA synthesis ceases and the pre messenger RNA is formed which will later be modified. [1]

**Question 5a**

A reflex arc is an automatic response that occurs without involvement of the brain. [1]

**Question 5b**

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 5c**

[1] for each row if both boxes are filled out correctly.

	<b>Brief description of function</b>
Interneurons	Connects nerve impulses between sensory and motor neurons.
Sensory neurons	Carries information from the sensory receptors to the skeletal muscles.
Motor neurons	Carries messages from Central Nervous System to skeletal muscles.

[1] for each complete row, [3] in total.

**Question 6a**

An autoimmune disease occurs when the body identifies self-cells as non-self and attacks them. [1]

**Question 6b**

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 cytochrome 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 6c**

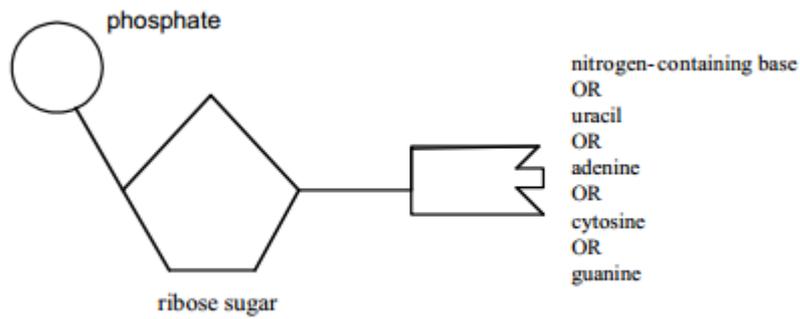
5 minutes after irradiation the healthy cells are beginning to undergo apoptosis, and so there is a high concentration of cytoplasmic cytochrome c. [1] After apoptosis has occurred and the cell has been broken down (20 minutes later), the cytochrome c has dispersed out of the cell. [1]

**Question 6d**

Viruses cannot be classified as cellular pathogens. [1] Viruses are obligate intracellular parasites that require other host cells to reproduce as they do not possess the cellular machinery to survive on their own. [1]

**Question 6e**

Cytotoxic T cells. [1]

**Question 7a**

[1] for correct diagrammatic structure.

[1] for correct labels.

In order to obtain full marks a schematic diagram as shown above is all that is required.

Labels must correspond to each of the components of the nucleotide.

Full marks cannot be granted if students do not specify ribose sugar. Just labelling sugar is not suffice.

Students should also be aware where the phosphate and the nitrogenous base link from the five sided sugar to obtain full marks.

**Question 7b i**

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

**Question 7b 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]

Students can elect to include diagrams in place of a sentence explanation, however each must be clearly labelled with the appropriate step name.

A maximum of [1] can be granted for each step.

**Question 7c**

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 Okazaki fragments [1] which are then joined together by DNA ligase.

**Question 8a**

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

**Question 8b**

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 8c**

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

**Question 9a**

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

Frog One: GGss (Green without spots)

Frog Two: ggSS (Yellow with spots)

F1 Frog: GgSs (Green with spots)

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

When answering any genetics questions be sure to explicitly state the allelic notation you will be using and make sure you clearly label your genotypes.

**Question 9 b i:**

Linked genes are genes that are found on the same chromosome [1] **and** are likely to be inherited together **or** do not assort independently **or** are relatively close together **or** crossing over can occur between them. [1]

The two marks allocated to this question indicates that students are required to make to separate points about linked genes.

The first point is **essential** without it no marks can be granted.

**Question 9b 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 9c**

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] awarded for punnet square showing this.

	A	a
A	AA	Aa
a	Aa	aa

**Question 10a**

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

**Question 10b**

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 10c**

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

**Question 11a**

Simply relying on an unpleasant taste means that predators have to learn not to eat these organisms by in fact first tasting them, this would mean that some species get half- eaten before the predator determines they are unpleasant. [1]

**Question 11b 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 11b 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. [1]

**Question 11c**

A range of responses are acceptable.

Below is an example of high-scoring response:

*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 11d**

Organisms that are able to interbreed to produce viable offspring. [1]

**Question 12a.**

Bipedalism [1]

## Question 12b

Feature	Brief description of changes
Spine	S shaped spine replaced the curved spine allowing erect movement [1], assisting in balance.
Position of the foramen magnum.	The position of the foramen magnum is at the skull base not at the rear of the skull. [1]