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# Unit 4 Biology

## Practice Exam Solutions

Stop!

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

Found a mistake?

Check the Engage Education 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 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 2

The correct answer is B. During transcription, thymine bases on the DNA strand would form complementary hydrogen bonds with uracil nucleotides, meaning that if we have 30% thymine on the original DNA then we will have 30% uracil on the messenger RNA.

### Question 3

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 4

The correct answer is B. Males only receive one X chromosome, so are more susceptible to be affected by X linked disorders.

### Question 5

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

### Question 6

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 7

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 8

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 9

The correct answer is D.

### Question 10

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 11

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

### Question 12

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 13**

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 14**

The correct answer is D. Humans have selected the pug dogs with the best looking 'squashed faces' and have desexed many individuals, greatly reducing the gene pool. This is artificial selection as it has been humans, not nature, that determines the fittest individuals for breeding.

**Question 15**

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

**Question 16**

The correct answer is B.

**Question 17**

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 18**

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

**Question 19**

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 20**

The correct answer is A. Although the short, broad pelvic bone is an example of structural evolution, it is not an example found in the picture. In the exam you must take information from the data if it is presented to you.

**Question 21**

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

**Question 22**

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

**Question 23**

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

**Question 24**

The correct answer is C.

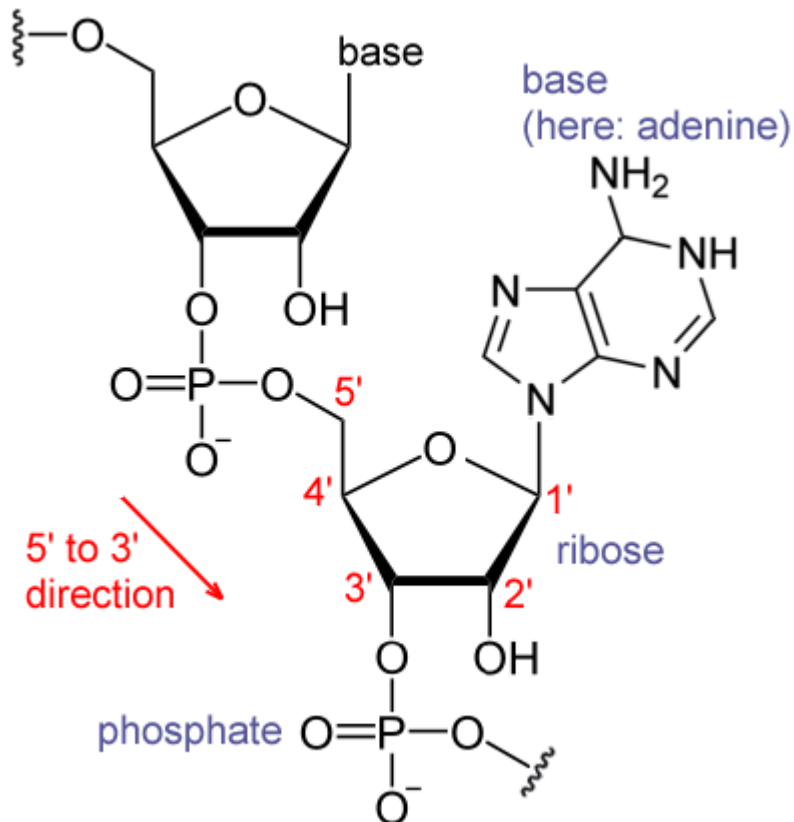
**Question 25**

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 one mark.

### Question 1a



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 1b 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 1b 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 1b 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 1c**

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 2a**

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

**Question 2b**

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

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

**Question 2c**

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

**Question 3a i**

Green (G) and spotted (S) are dominant to yellow (g) and without spots (s). [1]

Frog One: GGss

Frog Two: ggSS

F1 Frog: GgSs

[1] mark awarded if all genotypes are correct (different letters may be used for alleles).

**Question 3a 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 3a iii**

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

**Question 3b**

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 3c**

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 4a**

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

**Question 4b**

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

**Question 4c**

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

**Question 5a i**

BbCc [1]

**Question 5a ii**

BC, Bc, bC, bc [1]

**Question 5a iii**

[2] marks awarded for a completely correct answer.

Take [1] mark for every mistake.

	BC	Bc	bC	bc
BC	BBCC	BBCc	BbCC	BbCc
Bc	BBCc	BBcc	BbCc	Bbcc
bC	BbCC	BbCc	bbCC	bbCc
Bc	BbCc	Bbcc	bbCc	bbcc

**Question 5a iv**

9 Brown: 4 White: 3 Tan [1]

**Question 5b**

Recessive epistasis. [1]

**Question 5c**

The homozygous recessive cc alleles mean that no pigment is produced. [1] This means that any colour production is blocked. [1] In order for colour to be produced, horses need at least one dominant C allele.

**Question 6a**

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 6b**

Batesian mimicry. [1]

**Question 6c**

The caterpillars with bright colouration are less eaten due to their visual signals, thus they are able to survive more and thus reproduce more. [1] This means they are 'fitter' than those without bright colouration [1] and can contribute more genes to the next generation, putting them at a selective advantage. [1]

**Question 6d**

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 6e**

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

**Question 7a**

A frameshift mutation occurs as a result of an insertion or a deletion, so [1] mark will be gained for either the deletion of the seventh base or the insertion of another base either before or after the seventh base.

**Question 7b**

Messenger RNA is synthesised in a process called transcription. [1] 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 7c**

The polypeptide will most likely be ineffective [1], as every codon on the messenger RNA following the frameshift mutation will be altered, resulting in a completely different amino acid sequence. [1]

**Question 7d**

There are only 20 amino acids, but there are 64 possible combinations of 3 bases in the codons, thus there is some redundancy in the code. [1]