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Unit 4 Biology

Practice Exam Question and Answer Booklet

Duration: 15 minutes reading time, 1 hour 30 minutes writing time

Structure of book:

Section	Number of questions	Number of questions to be answered	Number of marks
A	25	25	25
B	5	5	50
Total			75

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers and rulers.
- Students are not permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied:

- This question and answer booklet of 15 pages.

Instructions:

- You must complete all questions of the examination.
- Write all your answers in the spaces provided in this booklet.

Section A – Multiple-choice questions

Instructions

Answer all questions by circling your choice.

Choose the response that is correct or that best answers the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will not be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Questions

Question 1

Prokaryotic cells replicate via:

- A. Binary Fission
- B. Mitosis
- C. Apoptosis
- D. Meiosis

Question 2

The genotype notation $\frac{AB}{ab}$ means that:

- A. The individual is homozygous
- B. Genes A and B assort independently
- C. Genes A and B are linked
- D. The allele would be found in a gamete

Question 3

Theoretically, what proportion of offspring from a cross between parental genotypes Pp;Qq;Rr;Ss and Pp;qq;Rr;Ss would have the genotype pp;qq;rr;ss?

- A. 1/256
- B. 1/128
- C. 1/64
- D. 1/32

The following information relates to questions 4 and 5

Gregor Mendel based much of his genetic discoveries on experiments involving the common pea plant. Colour is determined by two alleles, with yellow (Y) being dominant to green (y). Similarly, another gene determines texture with smooth (S) being dominant to wrinkled (s).

The genes assort independently. A student crossed a green wrinkled pea with a Smooth, Yellow pea to determine the yellow pea's genotype, and the results were as shown.

Phenotype of offspring	Number
Yellow, Smooth Peas	62
Yellow, Wrinkled Peas	58

Question 4

What type of cross has the student used to determine the genotype of the plant with yellow, smooth peas?

- A. A test cross
- B. A monohybrid cross
- C. A Dihybrid cross
- D. A back cross

Question 5

The genotype of the plant bearing the yellow, smooth peas is:

- A. YYSs
- B. YySs
- C. YySS
- D. YYSS

The following information relates to questions 6 and 7

Klinefelter's syndrome occurs when a male individual inherits an extra X chromosome. He produces less testosterone than normal males and is less muscular, as well as exhibiting other feminine features. It is often not diagnosed until the male reaches his teens and commences puberty, but may begin at any time in the male's life.

Question 6

The best way to diagnose this syndrome would be:

- A. DNA profiling (gel electrophoresis)
- B. Complete karyotyping
- C. Normal testosterone level analysis
- D. Pedigree chart

Question 7

The best term to describe the cause of this syndrome would be:

- A. Aneuploidy
- B. Polyploidy
- C. Mutation
- D. Non disjunction

Question 8

Helicase is used in:

- A. DNA replication, where the new DNA strand is synthesised in the 3' to 5' direction
- B. Transcription, where it separates the template strand of DNA
- C. Transcription, where it catalyses the production of messenger RNA strands
- D. DNA replication, where the new DNA strand is synthesised in the 5' to 3' direction

Question 9

If the cytosine content of a DNA sample is 23%, what percentage of the sample is adenine?

- A. 23%
- B. 54%
- C. 27%
- D. 46%

Question 10

A man is affected by a sex linked dominant trait. His wife however, is not affected. Which statement is true for their children?

- A. All daughters and none of the sons will have the trait
- B. Half of the daughters and half of the sons will have the trait
- C. Half of the daughters and none of the sons will have the trait
- D. There is a $\frac{1}{4}$ chance that each child may inherit the trait

Question 11

A cline is a:

- A. Geographic boundary separating two species that have diverged from one ancestral species
- B. A naturally occurring clone of a plant
- C. Continuous variation in the phenotype of a species over its range due to differences in the selection pressures of different environments.
- D. Variation in the genotype of a species over a geographical range due to different selecting pressures.

Question 12

Which of the following is NOT a potential cause of evolutionary change?

- A. Bottleneck effect
- B. Mutation
- C. Non-random mating
- D. Asexual reproduction

Question 13

A population is in genetic equilibrium. This means that:

- A. There are more heterozygotes than homozygotes in the population
- B. Allele frequencies in a population fluctuate around constant proportions
- C. Allele frequencies follow a constant generational pattern
- D. There are more homozygotes than heterozygotes in the population

Question 14

Gel electrophoresis can separate DNA samples based on their:

- A. Mass
- B. Charge
- C. Mass and Charge
- D. Relative proportions of purines and pyrimidines

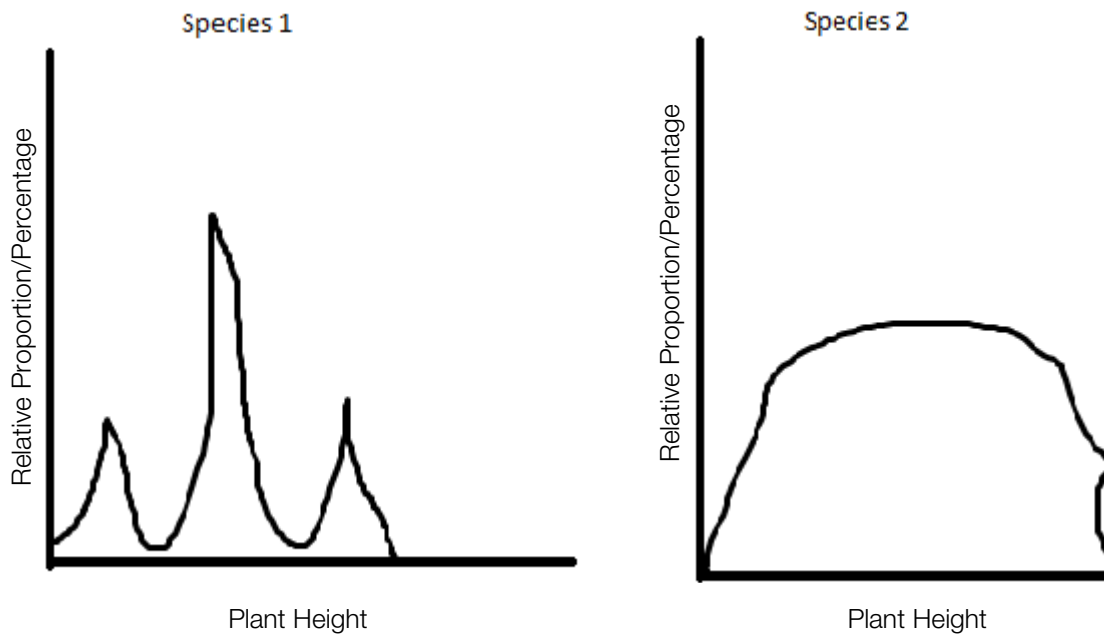
Question 15

DNA sampling produces unique DNA profiles of individuals, which have various uses, from determining paternities to determining who is guilty at a crime scene. This is due to the fact that each individual has a unique set of:

- A. Blood proteins
- B. Amino acids
- C. Genes in his/her chromosomes
- D. Variation in his/her DNA sequence

Use the following information to answer questions 16 and 17

A field biologist measured the heights of 200 grasses, 100 from species 1 and 100 from species 2. Study the following graphs. The area under the peaks corresponds to the frequency of the plants of each height.



Question 16

Which is the most likely mechanism for the control of height in Species 1?

- A. Height is controlled by two genes, each of which are co-dominant, and by environmental factors.
- B. Height is controlled by a single gene with a co-dominant allele, and by environmental factors.
- C. Height is controlled by a single gene with two alleles, and tall is dominant to short.
- D. Height is controlled by many genes, each of which have two co dominant alleles.

Question 17

The results obtained for species 2 are best explained by:

- A. There are many gene loci involved in the control of plant height.
- B. Environmental factors do not affect the growth of the plants
- C. Height is controlled at a single locus, but there are many alleles involved
- D. Height is determined by environmental factors only

Question 18

An unusually high incidence of a particular genetic trait was found in a small, isolated, population of bears. This was most likely a result of:

- A. Convergent evolution
- B. Divergent evolution
- C. Genetic drift
- D. Speciation

Question 19

A fossil was found of a primate. Which piece of evidence would be useful in determining whether it was an ape or an early hominid?

- A. It had opposing digits
- B. It was determined to be approximately 2 and a half million years old
- C. Its jaw was parabolic in shape
- D. The fossil had a wide trunk, relative to its body length

Question 20

A gene coding for a naturally occurring protein that acts as an insecticide, found in certain bacteria, was inserted into a plant crop in a bid to reduce the use of chemical sprays as insecticide. The plant species was thus:

- A. A vector
- B. A clone
- C. A transgenic organism
- D. A plasmid

Question 21

Which of the following structures indicate convergent evolution?

- A. Comparative embryology
- B. Vestigial structures
- C. Homologous structures
- D. Analogous structures

Question 22

The following table depicts the number of amino acid differences in a polypeptide found in a large number of primate species, and can be used to determine an estimate of evolutionary distances.

Species compared	Number of amino acid differences
Man vs Chimpanzee	0
Man vs Gorilla	4
Man vs Monkey	11
Monkey vs Chimpanzee	11
Money vs Gorilla	15

It is thus reasonable to conclude that:

- A. Humans and gorillas may differ in more than four bases in the DNA sequence which codes for this protein
- B. Gorillas are more closely related to chimpanzees than humans are to chimpanzees.
- C. Monkeys and gorillas share a more recent common ancestor than do humans and gorillas
- D. Humans and chimpanzees have identical DNA sequences in the gene which codes for this protein.

Question 23

Recombination occurs during:

- A. Prophase 1 of mitosis
- B. Prophase 1 of meiosis
- C. Prophase 2 of mitosis
- D. Prophase 2 of meiosis

Question 24

The recessive allele for Tay Sach's disease is lethal when homozygous, meaning sufferers do not survive past the age of approximately 5 years. Two parents who are both heterozygous at this gene locus had a child. The chance that their adult child is heterozygous is:

- A. $\frac{3}{4}$
- B. $\frac{2}{3}$
- C. $\frac{1}{4}$
- D. $\frac{1}{2}$

Question 25

Examples of sexual reproduction include:

- A. Budding
- B. Vegetative reproduction
- C. Meiosis
- D. Fragmentation

Section B – Short-answer questions

Instructions

Answer all questions in the spaces provided.

In all questions where a numerical answer is required an exact value must be given unless otherwise specified.

In questions where more than one mark is available, appropriate working must be shown.

Unless otherwise indicated, the diagrams in this book are not drawn to scale.

Questions

Question 1

- a. An example of an X-linked recessive disorder is red-green colour blindness.
A woman with normal colour vision, whose father was colour-blind marries a colour-blind man.
What possible genotypes are there for the colour-blind man's mother?

2 marks

- b. Explain, using a punnet square, the probability that if the couple have a child, it will be a colour-blind boy.

2 marks

- c. What proportion of all the girls produced by these parents could be expected to have normal colour vision?

1 mark

- d. Of all the children of these parents, what proportion can be expected to have normal colour vision?

1 mark

Total: 6 marks

Question 2

Below is a depiction of the genetic code.

Codon – Base Position			Amino Acid
1	2	3	
A	A	A or G	Lysine
A	A	C or U	Asparagine
A	C	A C G U	Threonine
A	G	A or G	Arginine
A	G	C or U	Serine
A	U	A C or U	Isoleucine
A	U	G	Methionine
C	A	A or G	Glutamine
C	A	C or U	Histidine
C	C	A C G U	Proline
C	G	A C G U	Arginine
C	U	A C G U	Leucine
G	A	A or G	Glutamic acid
G	A	C or U	Aspartic acid
G	C	A C G U	Alanine
G	G	A C G U	Glycine
G	U	A C G U	Valine
U	A	A or G	NONSENSE – STOP
U	A	C or U	Tyrosine
U	C	A C G U	Serine
U	G	A	NONSENSE – STOP
U	G	C or U	Cysteine
U	G	G	Tryptophan
U	U	A or G	Leucine
U	U	C or U	Phenylalanine

- a. The genetic code is often described as redundant. What is meant by this term?

1 mark

- b. What is RNA polymerase and what does it do?

2 marks

- c. Are the codes represented in the table for DNA or RNA? Explain.

2 marks

- d. A healthy polypeptide has the following series of codons:

AUGCCUAGGGAAUGA

The following are two mutated forms of the messenger RNA molecule that code for the polypeptide above.

AUGCGUAGGGAAUGA (mutation a.)

AUGCCCUAGGGAAUGA (mutation b.)

What types of mutations are mutations a and b respectively?

2 marks

- e. Is an individual with mutation a. or an individual with mutation b. more likely to suffer serious consequences? Explain your choice.

2 marks

Total: 9 marks

Question 3

a. Define and give an example of the term 'bottleneck effect'.

2 marks

b. Chimpanzees are the closest living relative to modern humans (98% of our genomes are similar). Explain, in terms of natural selection, how the two species diverged.

3 marks

c. Explain, using examples, the differences between convergent and divergent evolution.

2 marks

- d. There are many techniques employed to provide evidence for evolution. Outline in brief detail three of these.

6 marks

Total: 13 marks

Question 4

Genetic technologies have come a very long way in the past few decades. Recently, much research has been put into the idea of harnessing the insulin producing gene in pig DNA and inserting it into the cells of humans with Type 1 Diabetes, as they lack the ability to produce this important hormone.

- a. Explain briefly the main steps involving in implanting this gene into a human cell, using diagrams.

4 marks

- b. The Polymerase Chain Reaction is an indispensable genetic tool used in replicating miniscule genetic samples into ones large enough for analysis.
- i. Give one example where the Polymerase Chain Reaction (PCR) could be useful.
 - ii. Outline the main steps in the Polymerase Chain Reaction, including the terms primers, annealing, heating, taq polymerase, semi-conservative. The use of diagrams is encouraged.

3 marks

Total: 7 marks

Question 5

A mouse breeder made the following cross.

Homozygous non-spotted female X homozygous spotted male

All of the offspring in the F1 were non-spotted

- a. Which phenotype is dominant?

1 mark

- b. The genotype of the male parent was *ss*. What is the genotype of the offspring (the F1 generation)?

1 mark

- c. What gametes the F1 mice will produce?

1 mark

- d. Two F1 individuals were crossed together and produced progeny. Fill in the appropriate details in the following table:

1 mark

- e. What proportion of the offspring will be spotted?

1 mark

- f. What proportion of the offspring will be homozygotes?

1 mark

- g. The mice breeder decides to buy a mouse with no spots. How will he determine its genotype?

1 mark

The colour of these spots in the mice is variable. That is, there are black spotted, brown spotted and mice with black and brown spots. The breeder crossed two different strains of non-spotted mice together and obtained large numbers of offspring in the ratio below:

1 Black Spotted : 2 Black and Brown Spotted : 1 Brown spotted : 12 non spotted

- h. Using appropriate genetic terminology, explain these results. A punnet square may be useful.

2 marks

- i. Assign every possible genotype to each of the following phenotypes:

Phenotype	
Non-spotted	
Brown-spotted	
Brown and Black-spotted	
Black-spotted	

6 marks

Total: 15 marks

End of Booklet