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Unit 4 Biology

Practice Exam Question and Answer Booklet

Duration: 15 minutes reading time, 90 minutes writing time

Structure of book:

Section	Number of questions	Number of questions to be answered	Number of marks
A	25	25	25
B	7	7	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 19 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

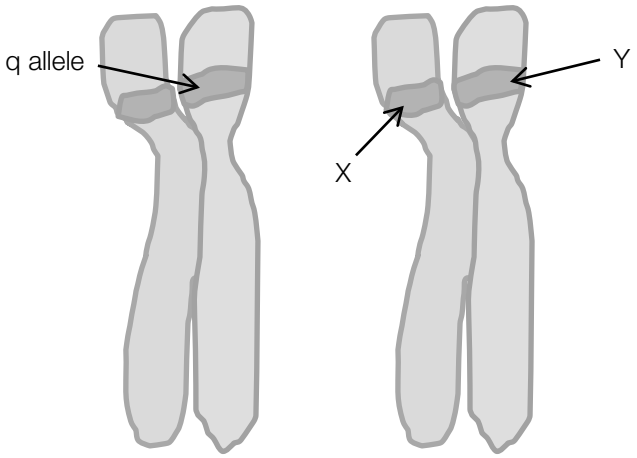
Instructions

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

Consider the following diagram of a homologous pair of chromosomes containing the gene for keratin content of finger/toe nails. Low keratin content (Q) is completely dominant to high keratin content (q).



The band represented by Y:

A. Must contain a q allele
B. Must contain a Q allele
C. Must contain the same DNA sequence as X
D. Must contain an alternative DNA sequence to X

Question 2

Chemical analysis of a section of DNA determined that its thymine quantity was 30%. What would be the percentage of uracil on the mRNA coded for by this gene (assuming no splicing of introns or addition of bases following transcription)?

A. 20%
B. 30%
C. 40%
D. 60%

Question 3
Which of the following is true of prokaryotic and eukaryotic nuclear organisation?

A. Eukaryotes organise their genes on a chromosome, whereas prokaryotes lack a chromosome
B. A eukaryote's linear chromosomes are contained within the nucleus, whereas DNA in prokaryotes exists free in the cell
C. Eukaryotic nuclear division includes the splitting of homologous pairs whereas prokaryotic nuclear division only involves the splitting of chromosomes into chromatids
D. Eukaryotic cells cannot take up foreign DNA while prokaryotic cells can take up and express foreign DNA

Question 4
Males have a greater chance of being affected by X-linked disorders because:

A. They possess two copies of the chromosome containing the gene
B. They contain one copy of the chromosome containing the gene
C. A gene on the Y chromosome makes males more susceptible to disease
D. Males possess less chromosomes than females

Question 5
Apoptosis is:

A. A method of recycling the contents of a cell
B. Used in order to silence DNA during gene regulation
C. Only seen to be occurring during the onset of diseases such as cancer
D. The regulated destruction of cells

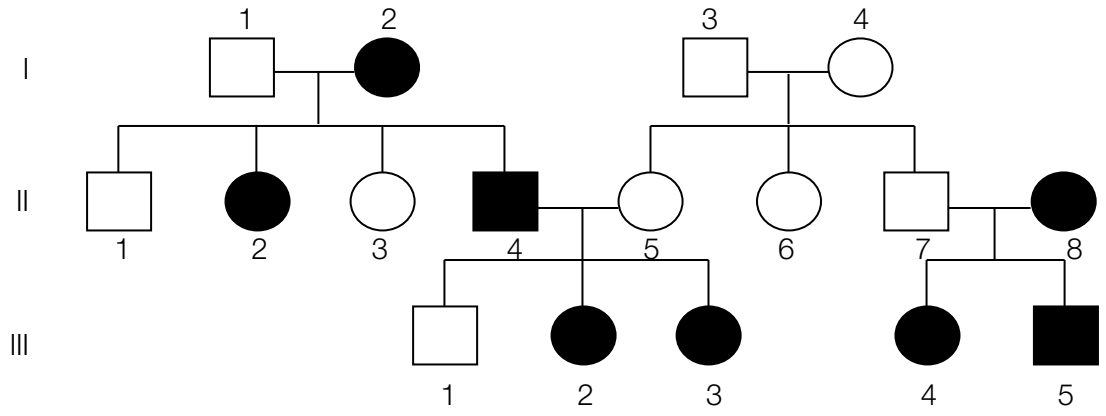
Use the following information to answer question 6, 7 and 8:

Congenital hemidysplasia with ichthyosiform erythroderma and limb defects (also known as CHILD syndrome) is a disease associated with a mutation on the NSDHL gene. This gene codes for an enzyme, 3-beta-hydroxy sterol dehydrogenase, which is integral in the synthesis of cholesterol in the body from harmful substrates. The following sequence of DNA shows the mutation that leads to a slight alteration of the active site of 3-beta-hydroxy sterol dehydrogenase:

Normal gene: 3' – A T T C A G T A A A C G C C T A G C C A A – 5'

Mutated gene: 3' – A T T C A G T A A G C G C C T A G C C A A – 5'

Examine the following pedigree of a family containing some sufferers of CHILD syndrome:



Question 6

The mode of inheritance for CHILD syndrome is:

A. Autosomal dominant
B. Autosomal recessive
C. X-linked dominant
D. X-linked recessive

Question 7

For the NSDHL gene, individual III-2 is:

A. Homozygous
B. Heterozygous
C. Hemizygous
D. Nullizygous

Question 8

From the information, it is possible to conclude that type of mutation leading to misproduction of 3-beta-hydroxy sterol dehydrogenase is:

A. A silent mutation
B. A missense mutation
C. A nonsense mutation
D. A frameshift mutation

Question 9

The Principle of Independent Assortment states that:

A. In mitosis, daughter cells receive a completely random combination of chromosomes
B. In mitosis, daughter cells receive one chromosome from a homologous pair at random
C. In meiosis, daughter cells receive a completely random combination of chromosomes
D. In meiosis, daughter cells receive one chromosome from a homologous pair at random

Question 10

Hydrangea macrophylla is a type of flowering plant that is native to parts of Asia and the Americas. In this plant, the colour of the flower is under the control of one gene, in which white is completely dominant to blue. It is noticed that in particularly alkaline soils, the colour of the petals is seen to be pink.

The following table shows the number of individuals in a population of 200 expressing a particular phenotype, at different pH levels.

pH	White	Blue	Pink
2	143	51	6
5	152	35	13
7	92	20	88
11	62	12	126

It is reasonable to conclude that:

A. Both the white and blue alleles are expressed and pink is the intermediate phenotype
B. The phenotype of the plant is influenced by both the genotype and environment of the plant
C. If two pink plants are crossed they will produce 100% pink offspring
D. *H. macrophylla* produce diploid gametes

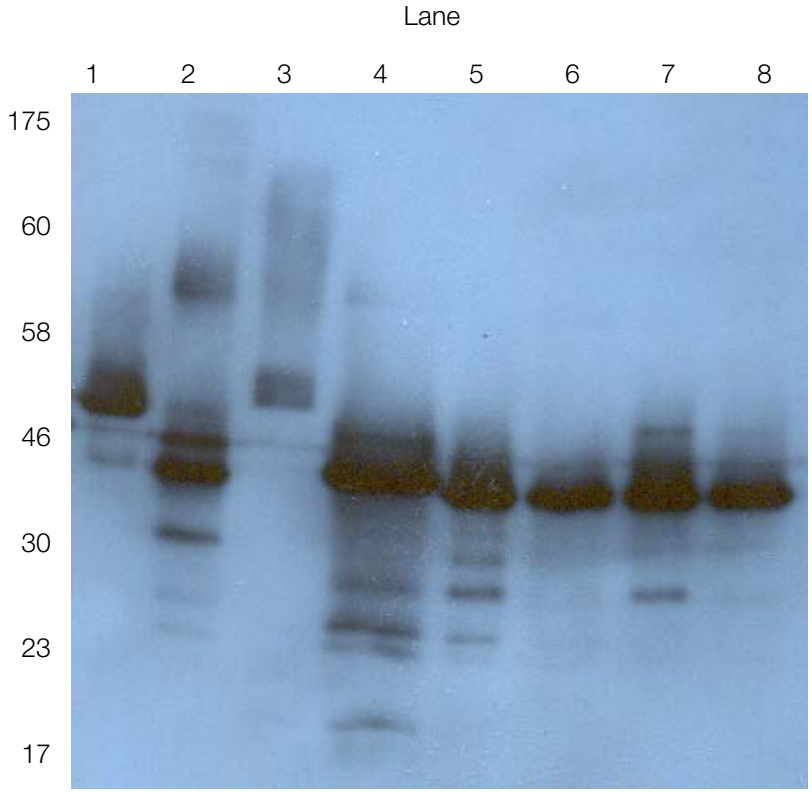
Question 11

DNA helicase:

A. Is composed of repeating units of nucleotides
B. Joins Okazaki fragments on the lagging strand during DNA replication
C. Is most active during the S phase of the cell cycle
D. Moves in one direction along a single-stranded DNA molecule

Question 12

Examine the following results resulting from the use of gel electrophoresis:



It is reasonable to conclude that:

A. The DNA samples in lane 2 and 4 are identical
B. The molecules of DNA in lane 1 have, on average, a larger molecular weight than those in lane 8
C. Lane 7 contains one fragment of DNA
D. Lanes 5 and 6 must contain DNA sourced from different individuals

Question 13

Transgenic organisms:

A. Are infertile
B. Result from natural selection
C. May result when foreign DNA is inserted into the nucleus of a fertilized embryo
D. May rely on viral delivery systems in order to deliver foreign DNA to somatic tissue

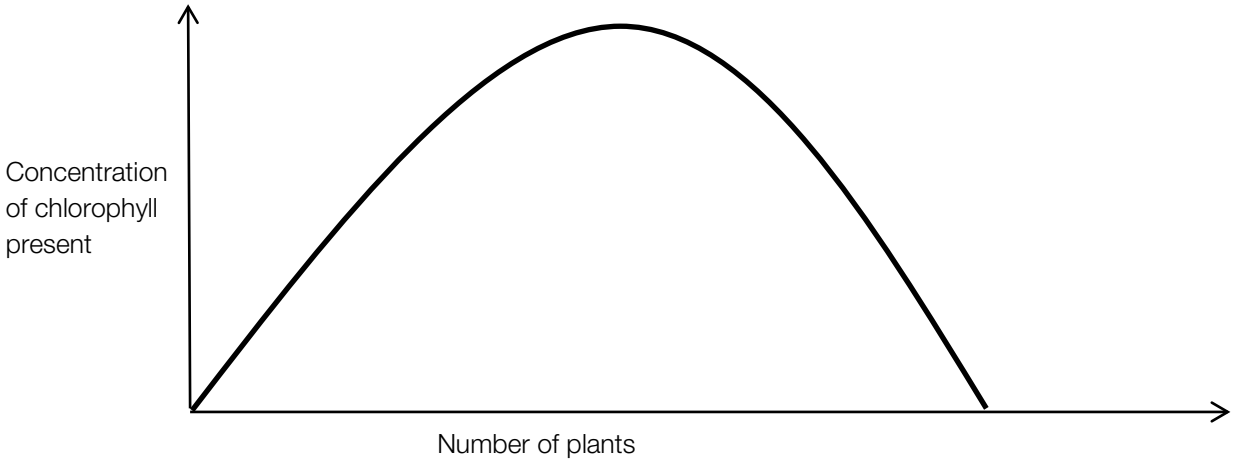
Question 14

There are approximately 10,000 pug dogs in Britain; however their gene pool only equates to that of about 50 individuals. This lack of genetic variation is due to:

A. Natural selection
B. Mutation
C. The bottleneck effect
D. Artificial selection

Question 15

The following graph shows the variation in chlorophyll levels of plants samples from a rainforest.



From the information it can be concluded that concentration of chlorophyll in individual plants:

A. Displays continuous inheritance
B. Displays discontinuous inheritance
C. Is under the control of one gene
D. Is under the control of more than two alleles

Question 16

Natural selection acts upon an individual's:

A. Genotype
B. Phenotype
C. Environment
D. Chromosomes

Question 17

A fossilised mammalian skeleton is found. Using stratigraphy it is estimated that the fossil is 25, 000 years old. Which would be the best choice of isotope to test for in the fossil to support the hypothesis that the fossil is 25,000 years old?

A. Carbon – 13
B. Uranium – 235
C. Lead – 207
D. Carbon – 14

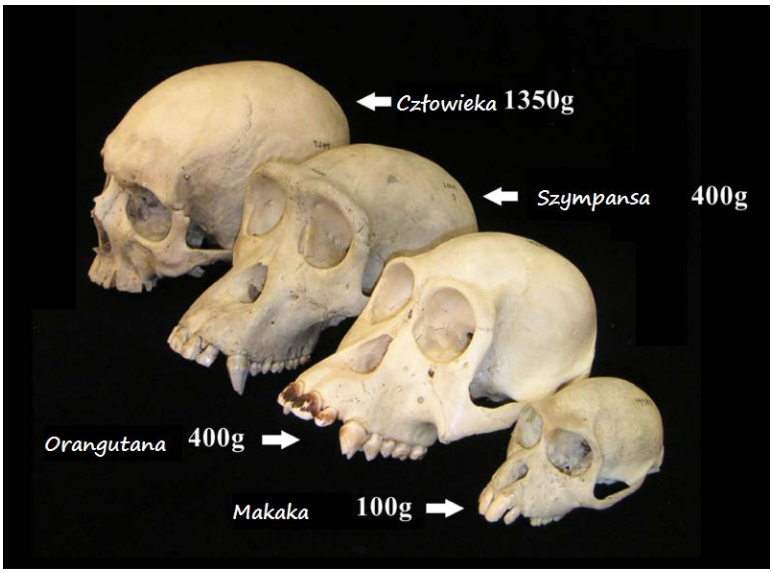
Question 18
An example of fossil evidence for human cultural evolution is:

A. A fossilised jaw bone containing small, evenly sized teeth
B. A fossilised rock tool found near human remains
C. A skull containing a large brain case
D. A skull with the position of the foramen magnum at the base of the skull, rather than at the back

Question 19
The species *Homo Neanderthalensis*

A. Were more closely related to apes than humans
B. Had larger brains than modern humans
C. Were disinterested in chasing large game, leading to their lack of survival when compared with *Homo Sapiens*
D. Were slightly taller than modern humans

Question 20



Source: Wikimedia Commons

Based on the image above, which of the following is NOT evidence of structural change that occurred during Hominid evolution.

A. Shorter and broader pelvis
B. Flattening of the face
C. Enlargement of the frontal lobe proportional to the rest of the brain, resulting in an increased cranial cavity
D. Decreased prominence of brow ridges

Question 21
Which of the following is an absolute technique to measure of the age of fossils?

A. Carbon dating
B. Comparative Embryology
C. Stratigraphy
D. Homologous features

Question 22
Which of the following is NOT an example of convergent evolution?

A. The use of echolocation as a means of communication seen in both bats and dolphins
B. Finger to toe membranes observed in the marsupial sugar glider and the flying squirrel
C. The 'camera' eye design observed in both cephalopods (i.e. squid) and vertebrates (i.e. mammals)
D. Opposable digits seen in both apes and humans

Question 23
A similar underlying bone structure is seen between the forearm of a man and a whale. This is an example of:

A. Analogous features
B. Homologous features
C. Symmetrical features
D. Convergence

Question 24
DNA Ligase:

A. Separates the two parent DNA strands at the commencement of DNA replication
B. Joins the DNA polymerase to the DNA so that new strands can be created in a semi conservative fashion
C. Creates phosphodiester bonds between adjacent Okazaki Fragments
D. Synthesises Okazaki Fragment on the lagging strand during DNA replication

Question 25
In the stratum of a sample of volcanic rock, the amount of ^{235}U (Uranium 235) is measured at 300 arbitrary units. The half-life of ^{235}U is 700 million years. In a newly formed rock of the same type of the sample, the amount of ^{235}U is measured at 1200 arbitrary units. How old is the volcanic rock sample?

A. 700 million years
B. 1.4 billion years
C. 350 million years
D. 2.1 billion years

Section B – Short-answer questions

Instructions

Answer all questions in the spaces provided.
Unless otherwise indicated, the diagrams in this book are not drawn to scale.

Questions

Question 1

a. Draw the structure of two nucleotides connected in one strand of RNA, indicating the strand's direction.

3 marks

b. The polymerase chain reaction (PCR) is a useful tool for amplifying samples of DNA so that they can be more easily analysed.

i. In order to carry out PCR, what 'ingredients' are required?

1 mark

ii. Summarise the main steps involved in PCR. You may use diagrams in your answer.

3 marks

iii. Compare two fragments of DNA – One is made up of 40% cytosine – guanine pairs and the other is made up of 60% cytosine and guanine pairs. Which will require a greater temperature in order to separate the strands?

2 marks

The process of PCR is based upon the natural process of DNA replication.

c. Outline how the leading and lagging strand are defined in DNA replication.

2 marks

Total: 11 marks

Question 2

Messenger RNA (mRNA), produced in transcription in the nucleus is able to migrate to ribosomes in the cytosol and provide the code for polypeptide formation.

a. Name one other type of RNA.

1 mark

b. Briefly describe the function of this RNA type.

1 mark

c. Messenger RNA must be processed before it can leave the nucleus. Briefly describe the steps taken in this post transcriptional modification before the mRNA is ready to leave the nucleus.

3 marks

Total: 5 marks

Question 3

a. Two pure breeding frogs are crossed together. Frog one is green and does not contain spots; whereas Frog two is yellow and does contain spots.

The F1 generation are all green and spotted.

The F1 are then crossed many times and the numbers of offspring in the F2 are shown below.

Phenotype	Number of individuals
Green and spotted	902
Yellow and spotted	298
Green and without spots	303
Yellow and without spots	105

i. Which phenotypes are the dominant phenotypes? Assign allelic notation to Frog one, Frog two and the F1 frogs.

1 mark

ii. Are the genes for colour and spots assorting independently or are they linked? How do you know?

1 mark

iii. If you answered than the genes are assorting independently, what phenotypic ratio would you have expected in the F2 if the genes were linked? If you answered that the genes were linked, what phenotypic ratio would you have expected if the genes were assorting independently?

1 mark

b. Give an example of a phenotype produced by two co-dominant alleles, and compare it with an example of phenotype produced by two incompletely dominant alleles. What is the difference between co-dominance and incomplete dominance?

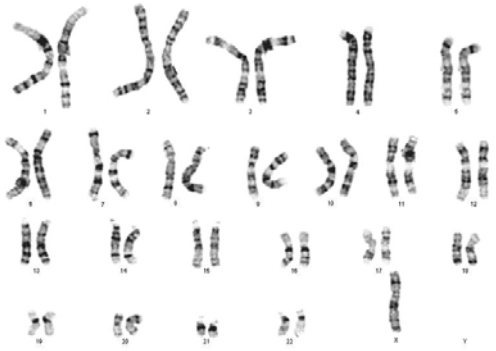
1 mark

c. Explain the phenotypic ratio obtained when two F1 individuals are crossed for a gene that is lethal when homozygous dominant. Use a punnet square in your answer.

2 marks

Total: 6 marks

Question 4



The figure above shows the karyotype of an individual affected by Turner's syndrome. Individuals with Turner's syndrome contain a germline mutation meaning they have only one copy of the X chromosome and no copies of the Y chromosome.

a. What are germline mutations?

1 mark

b. Would a woman with Turner's syndrome be able to reproduce? Why/Why not?

3 marks

c. What type of germline mutation has produced the Turner's syndrome? Make sure you include the stage of meiosis as which the mutation occurred in your answer.

2 marks

Total: 5 marks

Question 5

Horse coat colour is determined by the dominant allele B, which produces a brown colour, and the recessive b allele, which produces a tan colour. There is another gene coding for the presence of pigment in the horse's coat. The presence of the dominant allele for this gene, C, simply means that the horse will have coat colour. If the horse is homozygous recessive at this loci (cc) there is no pigmentation and the horse will be white regardless of alleles coding for brown or tan colour. The B locus and the C locus are independently assorting.

a. Two horses, heterozygous at both loci are crossed.

i. What is the genotype of the crossed horses?

1 mark

ii. What possible gametes could occur in each horse as a result of meiosis?

1 mark

iii. Fill in the following punnet square, outlining the cross.

2 marks

iv. What are the phenotypic ratios of the offspring?

1 mark

b.

i. The phenomenon analysed in part a, where the presence of a homozygous recessive combination of one gene masks the effect of another gene has a name. What is the name of this type of inheritance?

1 mark

ii. Explain how the presence of the homozygous recessive cc allele combination is blocking the production of colour, regardless of the B and b alleles.

2 marks

Total: 8 marks

Question 6

Many species use bright colours as a means to attract mates in the wild. Biologists have noticed that certain species of insect, frog, and caterpillar are also brightly coloured, though this adaptation appears to be a warning system that they are either poisonous or taste unpleasant.

a. What is the selective advantage of having bright colouration as a warning signal to predatory species, rather than simply relying on an unpleasant taste?

1 mark

b. Biologists working in the field have also noticed that species that are not poisonous are brightly coloured too. This is an example of mimicry. What type of mimicry is this?

1 mark

c. Use the example of brightly coloured caterpillars to explain Darwin's theory of natural selection.

3 marks

d. Give an example of genetic drift that could lead to speciation.

2 marks

e. What is the criterion for two different populations to be considered different species?

_____

_____

1 mark

Total: 8 marks

Question 7

a. Re-write the following DNA sequence, adding in a frameshift mutation by point mutation at the seventh base:

3' ATTCGATTGCCCATCTCGAAG 5'

1 mark

b. Explain, briefly, the events that occur during transcription.

3 marks

c. If a frameshift mutation has occurred, what consequence does this have on the polypeptide that the gene was coding for?

2 marks

d. What is meant by the statement 'the genetic code is degenerate'?

1 mark

Total: 7 marks