BIOLOGY

Unit 4 – Written examination 2

2010 Trial Examination

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: A

Explanation:
DNA is made up of nucleotide subunits each of which contain a phosphate group, a 5 carbon sugar and a nitrogenous base so the numbers of sugar molecules, phosphate groups and bases will be equal to each other.

Question 2

Answer: D

Explanation:
When DNA is transcribed both the introns and exons are copied, therefore the product of transcription is pre mRNA or the primary transcript. It is only after the introns have been removed, the exons spliced together and a poly A tail and methylated cap added that the molecule can be called mRNA.

Question 3

Answer: B

Explanation:
The purpose of the methylated cap and poly A tail is to enable mRNA to be oriented in the correct direction for translation to occur.

Question 4

Answer: A

Explanation:
It is only during meiosis that homologous pairs of chromosomes (bivalents) align.

Question 5

Answer: C

Explanation:

This diagram depicts crossing over. Chromatin is exchanged between sister chromatids resulting in recombinant chromosomes allowing an increase in variation.

Question 6

Answer: B

Explanation:
The 1:1 ratio in the offspring is a classic ratio which indicates a test cross occurs. 1 parent had to be heterozygous and the other homozygous for the recessive trait.

Question 7

Answer: B

Explanation:
The F1 generation will all be heterozygous and have the genotype C^RC^W. Crossing 2 pink flowers will yield the following result:

	C^R	C^W
C^R	$C^R C^R$	$C^R C^W$
C^W	C^RC^W	C^WC^W

The phenotypic ratio is 1 Red: 2 Pink: 1 White

Question 8

Answer: C

Explanation:
Neither trait is dominant; both are expressed in the heterozygote with the phenotype of the heterozygote being a blend of the red and white phenotypes.

Question 9

Answer: B

Explanation:
This trait is recessive as parents II-4 and II-5 are both unaffected but have 2 affected offspring III-1 and III-3.

If mode of inheritance was X linked recessive then II-5, the father of affected female III-3 would also have to be affected, since he is unaffected this trait cannot be X linked and must therefore be autosomal.

Question 10

Answer: C

Explanation:
Both parents have to be heterozygous so the outcome of this cross is:

	A	A
A	AA	Aa
a	Aa	Aa

Since individual III-2 is unaffected they cannot have the genotype aa, therefore the chance of them having the unaffected phenotype and being heterozygous is 2/3.

Question 11

Answer: D

Explanation:
Genes are linked when they are located on the same chromosome. They will be inherited together rather than being independently assorted.

Question 12

Answer: D

Explanation:
It is preferable to use an enzyme that produces sticky ends. Sau3A is the only enzyme that produces blunt ends making it the worst choice.

Question 13

Answer: A

Explanation:
PCR is the process of amplifying or making many copies of a DNA template.

Question 14

Answer: D

Explanation:
The DNA is cut into 3 smaller fragments, 2 small fragments that are similar in size and one that is comparatively long. The single long piece stays close to the wells, while the 2 smaller fragments travel further through the gel.

Question 15

Answer: B

Explanation:
Since the frequency of the "a" allele has dramatically increased there must be a selective advantage in having the aa genotype.

Question 16

Answer: A

Explanation:
Genetic drift is the chance change in the allele frequency of a gene pool over time.

Question 17

Answer: D

Explanation:
If the allele frequency remains stable then it would be reasonable to expect that the frequency of the traits also remains stable.

Question 18

Answer: A

Explanation:
When the temperature is changed the phenotype of the flies also changes, this means that the phenotypic variation must be caused by the environmental change.

Question 19

Answer: B

Explanation:
Sedimentary rocks are most likely to contain fossils as the process of forming sedimentary rocks is most conducive to fossilisation; rapid coverage and lack of oxygen.

Question 20

Answer: D

Explanation:
This diagram refers to relative dating. It cannot be used to infer anything other than the comparative age of fossils with the oldest fossils being in the lowest layer.

Question 21

Answer: C

Explanation:
This is an example of natural selection. Organisms with a favourable phenotype or more likely to survive and reproduce which means that the favourable trait will increase in the population in subsequent generations.

Question 22

Answer: C

Explanation:
Adaptive radiation occurs as a result of isolation and adaptation to different environmental conditions.

Question 23

Answer: B

Explanation:
If two species are closely related their DNA would have a greater similarity and a stronger bond would form between the 2 strands, so it would take a greater amount of heat to disrupt the annealed strands of closely related organisms than unrelated organisms.

Question 24

Answer: C

Explanation:
P. herberti and *P. inornata* share a common ancestor more recently than *P. brachotis* and *P. rothschildi* therefore their genetic similarity would be greater.

Question 25

Answer: C

Explanation:
Prokaryotic chromosomes are circular, do not have homologous pairs and are not membrane bound.

SECTION B: Short-answer questions

Question 1

a. Vector.

1 mark

b. The promoter is involved in gene regulation, it regulates whether the gene is turned on or off.

1 mark

c. The marker.

1 mark

AND

The screening stage is used to identify which bacteria are transformed. Not all of the bacterium will have taken up the recombinant Ti plasmid. The presence of the marker gene in a bacterium indicates that it contains the recombinant plasmid.

1 mark

d. The genetic code is universal; a codon always codes for the same amino acid.

1 mark

e. Plasmids are circular extra chromosomal DNA.

1 mark

Total 6 marks

Question 2

a. Let X^R = Red eyes, X^r = white eyes, Y = Y

Parent's phenotypes, White eyed female x Red eyed male

Parents genotypes: $X^r X^r$ x $X^R Y$

Gametes: X^r , X^r x X^R , Y

1 mark

AND

	X^R	Y
X^r	$X^R X^r$	$X^r Y$
X^r	$X^R X^r$	$X^r Y$

1 mark

AND

Genotypic ratio 50% $X^R X^r$: 50% $X^r Y$

Phenotypic ratio: 50% red eyed females: 50% white eyed male

1 mark

b. There are 2 phenotypes in the parental generation, 1 in the F1 generation and 4 in the F2 generation in the ratio of 9:3:3:1

1 mark

c. Let B = brown pigmentation and b = ebony pigmentation, Let L = long wings and l = vestigial wings.

1 mark

AND

F_2 BbLL, BbLl, BBLL, BbLl

1 mark

d. The phenotypic ratio is 9:3:3:1
The actual result is similar to, but not exactly 9:3:3:1.

1 mark

The reason for the variation is that the outcome of a genetic cross is due to the chance combination of gametes.

1 mark

e. The geneticist would have to perform a test cross by crossing an individual that is heterozygous at both loci with an individual that has both recessive traits.

1 mark

If the geneticist is correct then the phenotypic ratio of the offspring should be 1:1:1:1.

1 mark

Total 10 marks

Question 3

a. AUG UAU CGU GGG AUA GUA

1 mark

b. Met TYR Arg Gly Ile Val

1 mark

c. Translation

1 mark

d. Point mutation OR Substitution mutation

1 mark

e. In the initial sequence the second codon codes for TYR, in the altered sequence the second codon is a stop codon which codes for a release factor.

1 mark

As a result the polypeptide will be shorter than normal and will not be able to function.

1 mark

Total 6 marks

Question 4

a. Suspect 1 was wrongfully convicted.

1 mark

The bars in suspect 1's genetic fingerprint does not match the fingerprint from the crime scene, but the fingerprint from suspect 3 does,

1 mark

b. Electrophoresis

1 mark

c. Restriction enzyme or endonuclease

1 mark

A restriction enzyme binds to and cuts a specific recognition sequence of DNA.

1 mark

Total 5 marks

Question 5

a. Transitional or intermediate forms

1 mark

These fossils can be used to provide evidence showing how one species has evolved into another as they have features of both.

1 mark

b. The standard way of proving that two organisms belong to the same species is to determine if viable offspring are produced. It is not possible to interbreed 2 fossils.

1 mark

c. Potassium to argon dating.

1 mark

d. The P. problematicus fossils cannot be used as index fossils.

1 mark

One feature of index fossils is that they need to be present in large numbers, there are only two fossils found of p. problematicus, which is not sufficient.

1 mark

e. Scientists try to identify which modern organisms are the most closely related to the extinct species and apply information about the modern species to the extinct species.

1 mark

Total 7 marks

Question 6

a. The out of Africa or replacement theory.

1 mark

b. Ardi exhibited bipedalism.

1 mark

Since the organisation of the brain and spinal cord was positioned similarly to that of modern humans, the foramen magnum would be in a similar position to that of modern humans indicating bipedalism.

1 mark

c. The common ancestor of both Ardi and modern day apes did not have these traits, they developed after divergence occurred.

1 mark

d. Relative dating.

1 mark

The age of the fossils was determined relatively to the age of the two rock strata surrounding it.

1 mark

e. The DNA could have been degraded.
The DNA could have been contaminated.

1 mark each

f. Sediments provide the best conditions for fossilisation to occur – rapid coverage and lack of oxygen.

1 mark

Total 9 marks

Question 7

a. Biological evolution is the change in the physical properties of a species over time and it is underpinned by natural selection.

1 mark

Assistive reproductive technologies allow humans to overcome natural selection to a certain extent. These technologies allow the birth of children that would not happen by normal means therefore affecting the gene pool.

1 mark

b. His actions would contribute towards change.

1 mark

Stability in a gene pool is reliant on all individuals being equal in terms of reproductive success, by making a greater than normal contribution to that gene pool he is limiting variation and altering the allele frequency of the population, this is referred to as directional selection.

1 mark

c. She would achieve a positive result.

1 mark

Since pregnancy kits detect hCG, the kit would be detecting the hCG that she was injected with rather than the hCG produced as a result of pregnancy.

1 mark

d. Artificial selection

1 mark

Total 7 marks