BIOLOGY

Unit 2 – Written examination

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2021 Trial Examination

SOLUTIONS

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

Question 1
Answer: B

Explanation:
The number of chromosomes never doubles during the Cell Cycle. However, during S Phase, each chromatid in a chromosome replicates.

Question 2
Answer: A

Explanation:
In budding, the division of the cytoplasm is unequal, therefore option B is incorrect. Budding does not necessarily produce many offspring at once, therefore option C is incorrect. The 'creation of hard self-contained' capsules describes spore formation, not budding, so option D is incorrect.

Question 3
Answer: C

Explanation:
If linked genes are separated through the process of crossing over, recombinant gametes are produced.

Question 4
Answer: D

Explanation:
When a child is first conceived, it is referred to as a 'zygote,' which is the single cell formed from the combination of an egg and sperm. Once the first cell division is reached, it is called an 'embryo.' The embryo becomes a 'foetus' after 8 weeks.

Question 5
Answer: A

Explanation:
The image shows a cell which is in the process of dividing into two cells. A line is forming down the middle, separating the cell into two, and two distinct nuclei are present. The cell is therefore in either telophase or cytokinesis. Since cytokinesis is not one of the options, it must be telophase.

Question 6
Answer: C

Explanation:
Eukaryotes perform mitosis and apoptosis, and some also perform meiosis. Binary fission is only performed by prokaryotes. Some eukaryotes do perform 'fission,' but this is different from binary fission.

Question 7
Answer: B

Explanation:
Although 'oncogenes,' 'proto-oncogenes' and 'tumour-suppressor genes' are all genes which can be involved in causing cancer, the question asks for a gene which has been blocked. If tumour-suppressor genes are blocked, cells can grow out of control, causing cancer. On the other hand, if proto-oncogenes or oncogenes are blocked, this will slow cell division and therefore slow the development of cancer.

Question 8
Answer: A

Explanation:
Males inherit X chromosomes from their mother and not their father, so we cannot be certain of the condition of the X chromosomes in Justin's paternal line – therefore B and D are not correct. Justin must have inherited the defective X from his mother. Since this is a dominant condition, Justin's mother would have Incontinentia Pigmenti. Without further information, it is unclear which of Justin's mother's parents gave her the defective X, so C is not correct.

Question 9
Answer: C

Explanation:
The corn which Farmer Brock finds is wrinkled, which is a recessive trait (*ss*). Therefore D cannot be the correct answer.
The corn which Farmer Jack finds is purple, which is a dominant trait (*P*-), which means it must have at least one *P*, so B cannot be the correct answer.
One of the parental corn plants was yellow (*pp*), which means the corn in question must have inherited at least one *p*, so A cannot be correct.

Question 10
Answer: A

Explanation:
Alleles are specific variants of a gene.

Question 11
Answer: D

Explanation:
If non-disjunction occurs during Meiosis I, this means that three chromatids for a certain chromosome will go in one direction, and one chromatid will go in the other direction (rather than two and two). Therefore, after Meiosis II is finished, two of the gametes will have an extra chromosome (and will be n+1), and the other two gametes will be missing a chromosome (and will be n-1).

Question 12
Answer: C

Explanation:
The function of the M checkpoint is to ensure that the chromosomes have been correctly attached to the spindle. The other options listed are regulated by different checkpoints.

Question 13
Answer: C

Explanation:
The key step of a test cross is to cross the 'unknown' organism with a homozygous recessive organism – in this case the green dragonfly would be crossed with a brown dragonfly (*gg*). Since green is the dominant trait (G), a green dragonfly which is homozygous will have the genotype *GG.* A cross between *GG* and *gg* can only produce offspring which are *Gg,* so all of the offspring will be green.

Question 14
Answer: B

Explanation:
Independent assortment describes the phenomenon where each pair of chromosomes acts independently of what the other chromosome pairs are doing. Therefore, each pair lines up at the equator regardless of the configuration of the other chromosome pairs at the equator.

Question 15
Answer: D

Explanation:
Since the Indian elephant has a diploid number of 56, it would have 56 chromosomes in its somatic cells. At the end of S Phase, each chromosome has two chromatids. Therefore, by the end of S Phase, there would be 112 chromatids total.

Question 16
Answer: C

Explanation:
The patient is exceptionally short and has issues relating to a webbed neck – these are symptoms of Turner's Syndrome. The chromosome notation for Turner's Syndrome is XO, which means they are female and only have one X chromosome instead of two.

Question 17
Answer: D

Explanation:
Both mitosis and meiosis start with the diploid number of chromosomes – there is no difference in this aspect.

Question 18
Answer: C

Explanation:
Cloning involves making a new complete diploid organism. It uses an original diploid organism as the starting point.

Question 19
Answer: B

Explanation:
Thymine and adenine are complementary, and are joined together by two hydrogen bonds. Option D is incorrect because although guanine does pair with cytosine, they are joined by three hydrogen bonds, not two.

Question 20
Answer: A

Explanation:
Y is simply an allele, not a genotype, so option B is incorrect. Tall is a phenotype, so option C is incorrect. 1:2:1 is a ratio, so option D is incorrect. Yy is indeed a genotype, so option A is correct.

Question 21
Answer: B

Explanation:
Phenotype is the result of a complex interaction between genotype and the environment.

Question 22
Answer: C

Explanation:
The cross here would be ll x Ll. 50% of the offspring would have long tongues.

Question 23
Answer: D

Explanation:
If a chromosome has two chromatids, the two chromatids are held together at the centromere. A chromosome can have either one or two chromatids, therefore C is incorrect.

Question 24
Answer: B

Explanation:
The pedigree must be dominant as Individual 7 does not have the trait, but his parents do – this would not be possible if the trait was recessive.
It cannot be X-linked dominant, as Individual 9 is affected, meaning he would pass on his affected X to all of his daughters – but Individual 11 is one of his daughters, and she is not affected.
Therefore, it must be Autosomal Dominant.

Question 25
Answer: A

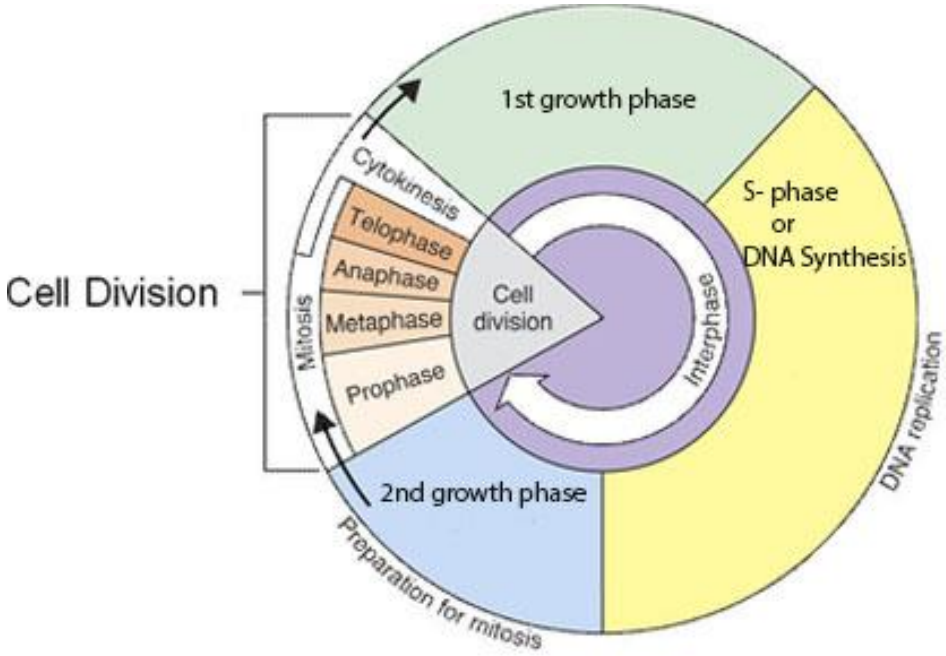
Explanation:
Sister chromatids line up down the equator in Meiosis II; sister chromosomes are pulled apart in Anaphase I.

SECTION B: Short-Answer questions

Question 1

a.

- Diagram of the cell cycle is in the correct basic 'circle-shape format' as shown below (1 mark).
- Interphase is split into G_1, S and G_2 phases (1 mark)
- Mitosis is correctly placed as occurring between G_2 phase and G_1 phase (1 mark)
- Mitosis is divided into smaller sectors labelled as 'Prophase' 'Metaphase' 'Anaphase' and 'Telophase.' Cytokinesis must also follow directly after these sub-phases (1 mark).



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4 marks

b.

- Blood cell tissue (1 mark)
- The blood cell tissue has a much higher mitotic index/rate of cell division (1 mark)
- Abnormally high cell division is a clear indicator of cancer (1 mark)

3 marks

c.

i.

- Stem cells have the ability to divide indefinitely (1 mark)
- Stem cells are able to differentiate into a wide variety of cell types (1 mark)

ii.

- Embryonic stem cells (1 mark)
- Embryonic stem cells are unpredictable/their development is not easily predictable (1 mark)

2 + 2 = 4 marks

Total 11 marks

Question 2

- Left-hand column identifies 3 primary germ layers as:
  - Endoderm (1 mark)
  - Mesoderm (1 mark)
  - Ectoderm (1 mark)
- Correct matching of body parts as per the below table (1 mark each, 5 marks total)

Name of Primary Germ Layer	**Body parts given rise to by this Germ Layer**
Endoderm	• Liver
Mesoderm	• Kidneys • Muscles
Ectoderm	• Brain • Mouth

Total 8 marks

Question 3

a.

- Vegetative propagation (1 mark)
- Part of a plant is detached and planted, which then grows into a new identical plant (1 mark)

2 marks

b.

- Ovum /Pollen (1 mark)
- These cells are gametes/haploid, and are used for sexual reproduction, not asexual reproduction (1 mark)

2 marks

c.

- Spore formation (1 mark)
- DNA is packaged into hard self-contained capsules, and then released into the air or environment (1 mark)
- *Or any other reasonable asexual method named and described*

2 marks

d. Any 3 of the following (1 mark each):

- Mass cloning of a population results in a lack of *genetic diversity*. If a pest or disease attacks a cloned crop, the entire population will be vulnerable.
- Preventing diversification from occurring requires lots of pesticides and fertilisers, which costs time and money.
- Reduced biodiversity in crops means that many of the beneficial insects (natural enemies of pests) are no longer present. Pest outbreaks are now more catastrophic.
- *Any other relevant response which deals specifically with cloned crops*.

e.

- Sexual reproduction involves meiosis (1 mark)
- In order for chromosome pairs to separate correctly in meiosis, there must be an even number of chromosomes (1 mark)
- *Wheatus maximus* has 63 chromosomes, therefore it will not be able to form chromosome pairs/its gametes will be non-viable.

3 marks

Total 12 marks

Question 4

a. The sum of all DNA in an organism, as measured in haploid base pairs.

1 mark

b. Any 2 of the following (1 mark each):

- Sequencing the genomes of individuals
- Comparing relatedness between species
- Determining gene function
- Early detection & diagnosis of diseases
- *Any other relevant response which involves a specific application of genomic data to society.*

2 marks

c.

i. Nucleotides

ii. Nitrogenous base

1 + 1 = 2 marks

d.

i. T C A C G A C T T G T A C T C A T T

ii.

- 1200 bases (1 mark)
- 2000 base-pairs means there are 4000 bases in total
- If 800 bases are guanine, then 2400 bases must be adenine & thymine. Half of 2400 is 1200, so there are 1200 adenine bases.

1 + 3 = 4 marks

e.

i. The study of the acquisition and inheritance of modifications to DNA expression which does not involve changes to the DNA sequences.

ii.

- DNA methylation involves methyl groups becoming attached to the DNA bases (1 mark)
- If a methyl group is attached to a certain part of DNA, it is less likely to be expressed (1 mark)

1 + 2 = 3 marks

Total 12 marks

Question 5

a.

i. Alleles should be comprised of a capital letter (no recessive alleles should be shown) and used consistently. Superscript letters are useful, but not essential. Therefore, genotypes should look similar to the following:

- $C^L C^L$ = Long tusks (1 mark)
- $C^S C^S$ = Short tusks (1 mark)
- $C^L C^S$ = Medium tusks (1 mark)

ii.

- Co-dominance occurs when the heterozygote fully expresses both alleles (1 mark)
- Complete dominance occurs when the heterozygote only expresses the dominant allele (*or equivalent answer*) (1 mark)

iii.

- No, it is not possible for medium tusks to be pure breeding (1 mark)
- When two medium-tusked walruses are crossed together, not all of their offspring have medium tusks (1 mark)

iv.

- Punnett Square parental gametes correctly set out (1 mark)
- Punnett Square correctly calculated, as per example below (1 mark)
- Genotype Ratio: 1 $C^S C^S$: 1 $C^L C^S$ (*or equivalent answer*) (1 mark)
- Phenotype Ratio: 1 medium tusk : 1 short tusk (*or equivalent answer*) (1 mark)

	C^S	**C^S**
C^L	$C^L C^S$	$C^L C^S$
C^S	$C^S C^S$	$C^S C^S$

v. Approximately 4 of the walruses would have medium tusks

3 + 2 + 2 + 4 + 1 = 12 marks

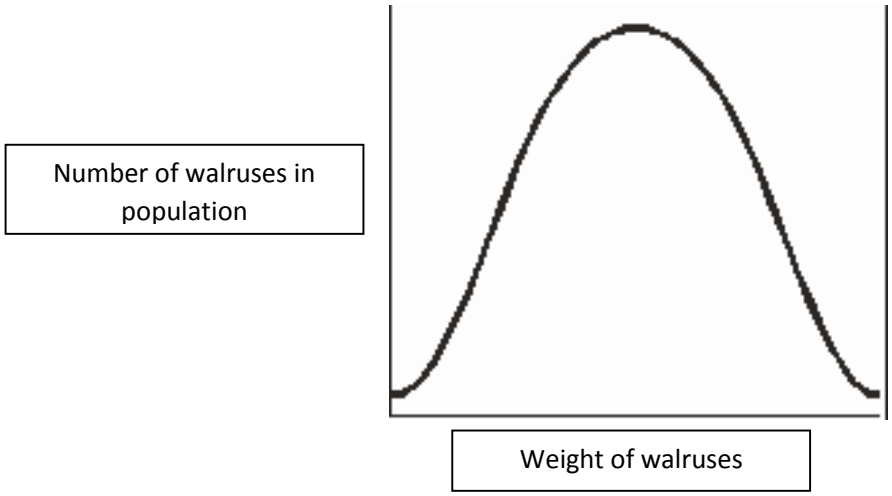
b.

i.

- Continuous variation is when a phenotype varies on a continuous spectrum, rather than as discrete traits (1 mark)
- Walruses can have a range of different weights (1 mark)

ii.

- Correct drawing of bell-shaped curve as shown below (1 mark)
- Correct labelling of both axes as shown below (1 mark)



2 + 2 = 4 marks

Total 16 marks

Question 6

a.

- DNA is wrapped around histone proteins (1 mark)
- When DNA is wrapped around a group of 8 histones, it is called a nucleosome (1 mark)
- The DNA and protein wrapped together is called chromatin (1 mark)
- When chromatin is further condensed, it forms chromosomes (1 mark)

4 marks

b.

i. This means the condition is caused by having three copies of chromosome 21.

ii. 47 chromosomes

iii. 23 or 24 chromosomes (*must mention both*)

1 + 1+ 1 = 3 marks

c.

- No, Klinefelter's Syndrome is not a sex-linked condition (1 mark).
- 'Sex-linked' refers to particular traits which are coded for by genes on a sex chromosome. Klinefelter's Syndrome does not refer to a single trait or gene. (1 mark)

2 marks

d.

i. Rachael = $X^h X^h$ (1 mark)
ii. Rachael's father = $X^h Y$ (1 mark)
iii. Rachael's maternal grandmother = $X^H X^h$ (1 mark)

(We know that Rachael's maternal grandfather does not have the trait, therefore he doesn't have an affected X chromosome. Therefore Rachael's maternal grandmother must have an affected X chromosome, because we know she passed a recessive allele onto Rachael's mother).

1 + 1 + 1 = 3 marks

Total 12 marks

Question 7

a.

- Correct parent genotypes identified, as shown below (1 mark)
- Correct calculation of offspring genotypes in Punnett Square (1 mark)
- **Genotype Ratio:** 1 CCNn : 1 CcNn : 1 CCnn : 1 Ccnn (1 mark)
- **Phenotype Ratio:** 1 Coarse Hair Long Nose : 1 Coarse Hair Short Nose (1 mark)

Parent Genotypes: *Ccnn* x *CCNn*

	Cn	**cn**		
CN	CCNn	CcNn		
Cn	CCnn	Ccnn		

Total 4 marks