Civics	Index	Name (use BLOCK LETTERS)	
Group	Number		H1



READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, civics group and index number on the multiple choice answer sheet in the spaces provided.

There are **25** questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C and D.

Choose the one you consider correct and record your choice in soft pencil on the separate multiple choice Optical answer sheet.

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INFORMATION TO CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for wrong answer. Any rough working should be done in this booklet.

At the end of the examination, submit <u>both</u> question paper and multiple choice answer sheet.

This document consists of **19** printed pages

[Turn over

1 The electron micrograph below shows an organelle.



Which of the following statements about the labelled structures are correct?

- 1. X serves to compartmentalise the organelle from the extracellular environment.
- 2. X is made up of a phospholipid bilayer and it is selectively permeable to substances.
- 3. Y has embedded proteins containing chlorophyll that are involved in the absorption of light.
- 4. Y has embedded ATP synthase that synthesizes ATP.
- 5. Z contains linear double-stranded DNA.
- 6. Z contains glycolytic enzymes that oxidises glucose to pyruvate.
- A 2 and 4
- **B** 5 and 6
- **C** 1, 2 and 4
- **D** 1, 3 and 6
- 2 Cells can be ruptured and their contents collected after a series of centrifugation at different speeds. At the end of every centrifugation set at a specific speed, a pellet containing specific organelles is formed. The supernatant is then centrifuged at a higher speed than previously and the new pellet formed collected. The process is repeated as outlined in the following diagram.



The sequence of pellets obtained in tubes 1, 2, 3 and 4 would be

- A ribosomes, endoplasmic reticulum, mitochondria, nuclei.
- B ribosomes, mitochondria, nuclei, endoplasmic reticulum.
- **C** nuclei, mitochondria, endoplasmic reticulum, ribosomes.
- **D** nuclei, endoplasmic reticulum, ribosomes, mitochondria.
- **3** The diagram below illustrates the process of phloem loading with the help of proteins 1 and 2.



Which of the following accurately describes the type of transport occurring at proteins 1 and 2?

	Protein 1	Protein 2
Α	Simple diffusion	Active transport
В	Active transport	Facilitated diffusion
С	Facilitated diffusion	Facilitated diffusion

Explanation

Transport proteins are required, hence simple diffusion should be eliminated [] Only active transport and facilitated diffusion are possible.

Protein 1: Transport of H⁺ is against concentration gradient and requires ATP [] Active transport Protein 2: Transport of H⁺ is down concentration gradient and requires transport protein [] Facilitated diffusion.

4 The graph below shows the amount of product formed in an enzyme-catalysed reaction over a certain period of time at 37° C.



5 Threonylvaline is a dipeptide formed from two amino acids, valine and threonine. A peptide bond forms between the amino group of valine and carboxyl group of threonine.

The R groups of the two amino acids are shown.



Which molecular structure is threonylvaline?



- 6 Which one of the following statements about haemoglobin is correct?
 - A Haemoglobin structure contains both α helices and β pleated sheets
 - B Haemoglobin has a quartenary protein structure with 4 identical subunits
 - C Haemoglobin structure involves hydrogen, ionic, disulfide bonds and hydrophobic interactions
 - D Haemoglobin contains 4 non-prosthetic heme groups
- 7 The diagram summarizes the process of photosynthesis.



Which row identifies the reactants 1, 2, 3, 4 and 5?

	1	2	3	4	5
Α	carbon dioxide	ADP + phosphate	reduced NAD	NAD	water
в	carbon dioxide	reduced NADP	ADP + phosphate	NADP	water
С	water	NAD	reduced NAD	ADP + phosphate	carbon dioxide
D	water	NADP	ADP + phosphate	reduced NADP	carbon dioxide

8 In an experiment, metabolically active cells were added to a container of nutrient solution. The container was then sealed. The graph shows the levels of glucose, carbon dioxide and oxygen over two continuous time intervals, X and Y.



Which of the following can be concluded from the graph?

- A The experiment is carried out on yeast cells. Fermentation occurs during interval **X** while aerobic respiration occurs during interval **Y**.
- **B** The experiment is carried out on animal cells. Aerobic respiration occurs during interval **X** while anaerobic respiration occurs during interval **Y**.
- **C** The experiment is carried out on yeast cells. Aerobic respiration occurs during interval **X** while fermentation occurs during interval **Y**
- **D** The experiment is carried out on animal cells. Anaerobic respiration occurs during interval **X** while aerobic respiration occurs during interval **Y**.
- **9** Trematol is a metabolic poison derived from the white snake root. Cows eating this plant concentrate the poison in their milk. The poison inhibits liver enzymes that convert lactate to other compounds for metabolism.

Which row illustrates the events that occur in an exercising athlete who consumed the trematol-tainted milk?

	lactate accumulation	NAD production	ATP production	pH of blood
Α	yes	yes	yes	decreased
В	no	yes	yes	decreased
С	yes	no	no	increased
D	no	no	no	increased



10 The graph shows changes in the amount of DNA during one cell cycle. The letters U – Z marks out the different phases in the cell cycle.



Name the events occurring at W, X and Y.

	W	Х	Y
Α	S phase	Anaphase	Telophase
В	Fertilisation	Interphase	Cytokinesis
С	S phase	Prophase	Cytokinesis
D	Fertilisation	Metaphase	Telophase

The photomicrograph shows cells in different stages of mitosis.





Which statements are correct?

- 1. Stage T shows metaphase.
- 2. DNA replication is occurring during stage R.
- 3. A cell in stage P and a cell in stage T have the same amount of DNA.
- 4. The correct order for the stages of mitosis is $S \rightarrow R \rightarrow T \rightarrow P \rightarrow Q$.
- **A** 1 and 4
- **B** 2 and 4
- **C** 1, 2 and 3
- **D** 1, 3 and 4
- 12 A fisherman was surprised to catch a fish which had no scales (nude). To investigate the origin of this phenotype, the nude fish was mated several times to fish with scales and the result of each cross was recorded. In the crosses of nude with scaled, a third phenotype appeared, which was later called linear. The linear phenotype has only a single line of scales down one side of the body.

The outcomes of these crosses are shown in the table.

Cross	Parents	Offspring phenotype and ratio
1	scaled x nude	all offspring linear
2	linear x linear	1 scaled : 2 linear : 1 nude

Which of the following is conclusive from the above data?

- A There is incomplete dominance between the nude and scaled phenotype.
- **B** The environment is the reason for the loss of scales in the nude fish.
- **C** All of the linear fish are homozygotes.
- **D** The nude fish are heterozygotes.

Explanation

A third phenotype is usually due to the presence of multiple alleles at a single gene, or incomplete dominance/ codominance.

Key:

 S^{N} ; N = Allele coding for absence of scales (nude) S^{S} ; S = Allele coding for presence of scales

Cross 1:

Parental phenotype:	Scaled	x	Nude			
Parental genotype:	S ^S S ^S	X	S ^N S ^N			
Gametes:	SS		S ^N			
F1 genotype: All S ^S S ^N			1			
F1 genotype: All linear	(=hetero	ozyg	otes ha	ve a differ	ent phe	notype)

Cross 2:

Parental phenotype:	Line	ar x	Linea	ar 👘
Parental genotype:	S ^S S	S ^N x	S ^S S	N
Gametes:	S ^S :	S ^N	S ^S S	S ^N
F1 genotype: 1 S ^S S ^S	- : `	2 S ^s :	S ^N :	1 S ^N S ^N
F1 genotype: 1 scaled		2 line	ar : '	1 nude
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13 Red-green colour blindness in humans is inherited in a sex-linked recessive manner. Another type of heritable colour vision deficiency in humans, known as blue-yellow colour blindness, is shown in the pedigree chart below.



Identify the option that shows **conclusive** evidence for the mode of inheritance of blue-yellow colour blindness.

- A The trait must be autosomal because there are equal frequencies of male and females inheriting the trait in generation II and generation III. The trait must be dominant because it appears in generation II and generation III. All offspring from this expanded pedigree will always be at risk of the trait.
- **B** The trait must be X-linked as **I2** blue-yellow colour blind mother has **II3** son and **II5** daughter with same trait. The trait must be recessive as the parents **I1**, **II4** and **II6** must be carriers.
- C The trait must be autosomal as **II3** blue-yellow colour blind father has son **III4** with the same trait. The trait must be dominant as children **III1** and **III2** will normal vision must have parents **II1** and **II2** with normal vision.
- **D** The trait must be X-linked as **II5** blue-yellow colour blind mother has son **III6** with normal vision and son **III5** with the same colour blindness. The trait must be dominant since **II5**, a heterozygote has blue-yellow colour blindness.
- - Which row correctly describes the bonds shown in the diagram at positions 1, 2, 3 and 4?

	Can be found in RNA	Is formed by condensation	Is formed during DNA replication	Is easily broken by changes in temperature or pH
Α	1, 2	2, 3	1, 2, 3	4
в	3, 4	5	2,3	2, 3
С	1, 2, 3	1, 2	1, 4	3, 4
D	1	1, 3, 4	1, 2	3, 4

15 Bacteria were grown in a medium containing ¹⁵N. After several generations, all of the DNA contained ¹⁵N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ¹⁴N. The bacteria were allowed to divide once. The DNA of some of these

bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ¹⁴N and ¹⁵N.

Some bacteria from the medium with ¹⁵N were transferred into a medium of ¹⁴N. The bacteria were allowed to divide twice. The graph shows the percentages of ¹⁴N and ¹⁵N in the DNA of these bacteria.



Some bacteria from the medium with ¹⁵N were transferred into a medium of ¹⁴N. The bacteria were allowed to divide three times.

What would be the percentages of ¹⁴N and ¹⁵N in the DNA extracted from these bacteria? [Ans: C]



16 Puromycin is an antibiotic produced by the bacterium *Streptomyces alboniger*. It is a potent translational inhibitor in both prokaryotic and eukaryotic cells.

Based on the information given, it is reasonable to conclude that puromycin works by preventing the

- A translation of the first codon which results in f-methionine being added.
- **B** formation of peptide bond between adjacent amino acids during translation.
- **C** association of 50S and 30S subunits of the ribosome.
- **D** binding of the ribosome to the promoter region of mRNA.

17 Which of the following statements may be concluded from this karyogram?



- 1. The person is male. [XX = female]
- 2. Non-disjunction has occurred. [Non-disjunction is responsible for a 2n+1 condition in this karyogram, as seen by an extra chromosome 13.]
- 3. A gene mutation has occurred in chromosome 3. [Bending of the chromosome as shown is <u>NOT</u> due to a change in DNA sequence]
- **4.** The person suffers from Down syndrome. [Down syndrome = Trisomy 21. There are only 2 chromosome 21s in this karyogram.]

A 2 only

- **B** 2 and 3 only
- C 1 and 4 only
- **D** 2, 3 and 4 only

18 Fabry's Disease is a disease that results from a mutation that occurs in the α -galactosidase A gene.

The sequence of part of the normal and mutated alleles for α -galactosidase A gene is shown below.

Normal a	llele								
Codon	37	38	39	40	41	42	43	44	45
mRNA	CCU	UGG	ACC	CAG	AGG	UUC	UAA	GGC	GGA
Mutated	allele								
Mutated Codon	allele 37	38	39	40	41	42	43	44	45

Using the information of the normal and mutated alleles above, it is reasonable to conclude that

- A A frame shift mutation has occurred.
- **B** A duplication has occurred.
- C An insertion of an amino acid has occurred in the mRNA.
- **D** The polypeptide that is translated from the mutated allele will be longer.

Explanation

- UAA is a stop codon
- $A \rightarrow$ no frameshift as three bases are inserted
- $C \rightarrow$ not mRNA but polypeptide
- **19** Induced pluripotent stem cells are stem cells that can be generated directly from differentiated somatic cells under the influence of molecular signals.

Which of the following statements are true?

- 1. An induced pluripotent stem cell can become any cell of the developed organism, but cannot produce trophoblast and placenta to support organismal development, whereas a totipotent stem cell can produce a whole organism including extraembryonic tissue.
- **2.** A totipotent stem cell and induced pluripotent stem cell can give rise to any cell type, including the extraembryonic membranes.
- **3.** An induced pluripotent stem cell can give rise to a single cell lineage whereas a totipotent stem cell can give rise to multiple, but limited number of cell lineages.
- 4. A totipotent stem cell can become any cell of a developed organism, but cannot produce extraembryonic tissue to support organismal development, whereas an induced pluripotent stem cell can produce a whole organism including extraembryonic tissue.
- 5. Induced pluripotent stem cells have the same developmental potential as embryonic stem cells.

- A 1 only
- B 1 and 5 only
- **C** 2, 3 and 4 only
- **D** 3, 4 and 5 only
- **20** Which one of the following statements is related to the principle of adaptive radiation in evolution?
 - A Unrelated organisms living in similar environments may tend to resemble each other.
 - **B** Related organisms living in different environments show modifications of an underlying unity of pattern.
 - **C** Selection in a constant environment tends to maintain the most frequently occurring variety of a species.
 - **D** Species evolve by selection altering the gene frequencies in interbreeding populations.
- **21** Approximately 1 in 25 people of northern European descent carry the most common allele causing cystic fibrosis (CF).

This mutant allele removes one amino acid from the amino acid chain of an ion channel, so that the chain cannot be folded into its correct shape.

Gut cells with a single copy of this mutant allele took up 80% fewer Salmonella typhi than normal cells. The bacterium *S. typhi* causes the gut infection typhoid fever.

Which suggestion could provide an explanation for the number of people carrying this mutant allele?

- A The selective pressure against individuals with CF and the selective advantage of the heterozygotes are removing the dominant allele from the population.
- **B** The selective pressure against individuals with CF and the selective disadvantage of the heterozygotes are removing the recessive allele from the population.
- **C** The selective advantage of the heterozygotes prevents the selective pressure against individuals with CF from removing the recessive allele from the population.
- **D** The selective disadvantage of the heterozygotes prevents the selective pressure against individuals with CF from removing the recessive allele from the population.
- **22** In some Australian insects, new species have arisen through changes that occurred to chromosomes in an ancestral species. Such changes may involve the joining together of chromosomes, the loss of whole or parts of chromosomes, and rearrangement of the genetic material within chromosomes.

One ancestral species has the following haploid set of chromosomes.

ancestral species



As the changes in chromosomes accumulate, a number of different species can result from a single ancestral species.

Three species that have evolved from the ancestral species shown above have the haploid sets of chromosomes shown below.



23 The data below shows the carbon dioxide emission from 1950 to 2010.



Which of the following could **not** account for the trend seen between 1998 to 2003?

- A Declining fossil fuel use associated with recession.
- B Conversion of intensive farmland into woodland reserves.
- **C** Stabilising of earth's natural systems.
- D Greater funds for energy efficiency projects worldwide.
- 24 Warmer temperatures are forcing birds in pine forests to breed farther north. Many species once found farther south are also expanding their ranges.

The graph below shows the average latitude occupied by 305 bird species in North America during the winters of 1966 to 2013. The shaded band shows the range of latitudes occupied by the birds.





Adapted from: https://www.massaudubon.org/our-conservation-work/climate-change/effects-ofclimate-change/on-birds

What could explain the observation?

- 1. Seasonal birds begin their migration earlier, and lay eggs earlier, in response to warming forest climate.
- 2. Birds are mobile, thus do not need to adapt and can switch their home ranges and habitat to find more suitable breeding grounds.
- **3.** As temperature rises, hardwood forests in the north lose their advantage, and pine forests found in the south now cover the northern region.
- **4.** As temperature rises, birds experience warmer winters that increases their reproductivity, resulting in larger bird populations.
- A 2 only
- B 2 and 3 only
- **C** 1, 2 and 4 only
- **D** 1, 3 and 4 only
- **25** Crop pests such as *Phytophthora infestans*, which caused the Irish potato famine, are moving towards the poles at about the same speed as warmer temperatures. The finding suggests that climate change is driving their relocation, and raises major concerns about food security in the poles.

Which of the following are possible explanations for these findings?

- 1. Increased temperatures cause the pests to adapt to higher temperatures.
- 2. Increased temperatures allow more crops to be grown in the cold areas now and hence, result in higher incidences of infestation.
- **3.** Increased temperatures disrupt the pests' life cycle and results in fewer pests being able to reproduce.
- **4.** Increased temperatures allow more pests to survive in the originally cold areas and results in an increase in the pest population.

