Neap:

Trial Examination 2008

# VCE Biology Unit 3

## Written Examination

## Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

**Structure of Booklet**

| Section | Number of questions | Number of questions to be answered | Number of marks |
|---|---|---|---|
| A | 25 | 25 | 25 |
| B | 8 | 8 | 50 |
| | | | Total 75 |

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners 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**

Question and answer booklet of 20 pages.
Answer sheet for multiple-choice questions.

**Instructions**

Write your **name** and **teacher's name** on this booklet and in the space provided on the answer sheet for multiple-choice questions. All written responses should be in English.

**At the end of the examination**

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.**

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## SECTION A: MULTIPLE-CHOICE QUESTIONS

**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** for 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.

**Question 1**

Water serves as a solvent in biological stems.

With regard to this role, it is most important that water

**A.** is non-polar.
**B.** is polar.
**C.** is organic.
**D.** solidifies at room temperature.

**Question 2**

The chemical bonds that link amino acids together in a protein are called

**A.** hydrogen bonds.
**B.** peptide bonds.
**C.** glycosidic bonds.
**D.** phosphodiester bonds.

**Question 3**

Examples of lipids include

**A.** phospholipids and antibodies.
**B.** glucose and cellulose.
**C.** DNA and water.
**D.** triglycerides and steroids.

**Question 4**

Consider the following chemical reaction.

$$ATP \rightarrow ADP + P_i$$

The reaction could be described as

**A.** endergonic.
**B.** anabolic.
**C.** catabolic.
**D.** uphill.

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*Use the following information to answer Questions 5, 6 and 7.*

Consider the following DNA template strand.

AGCTGGACCA

**Question 5**

This strand of DNA contains the nucleotide called adenosine.

Adenosine is composed of three components, namely

**A.** a purine, a ribose and a phosphate.
**B.** a pyrimidine, a deoxyribose and a phosphate.
**C.** a purine, a nitrogenous base and a phosphate.
**D.** a nitrogenous base, a phosphate and a deoxyribose.

**Question 6**

The mRNA sequence complementary to the DNA sequence is

**A.** UCGACCUGGU.
**B.** TCGACCTGGT.
**C.** AGCUCCAGGA.
**D.** UGCTCCUCCU.

**Question 7**

The process that uses a DNA template to create an mRNA sequence is called

**A.** transcription.
**B.** DNA replication.
**C.** translation.
**D.** protein synthesis.

**Question 8**

Despite the limited number of different amino acids, many different types of proteins exist.

This is because

**A.** the size of any given amino acid can vary.
**B.** the chemical composition of a given amino acid can vary.
**C.** the sequence and number of amino acids in a given protein is unique.
**D.** the same amino acid can have many different properties.

**Question 9**

Consider a cell in a multicellular organism.

The proteome of the cell refers to

**A.** all the genes and gene products in the cell.
**B.** all the proteins within the cell at any moment in time.
**C.** all the DNA in the cell and its associated functions.
**D.** all the proteins within the cell throughout the cell's entire period of existence.

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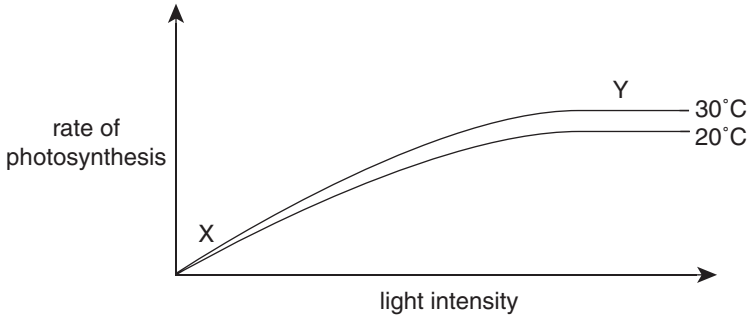
**Question 10**

The graph below shows the effect of environmental factors on the rate of photosynthesis by barley seedlings.




The graph shows that

**A.** carbon dioxide concentration is the factor limiting the rate of photosynthesis at point X.

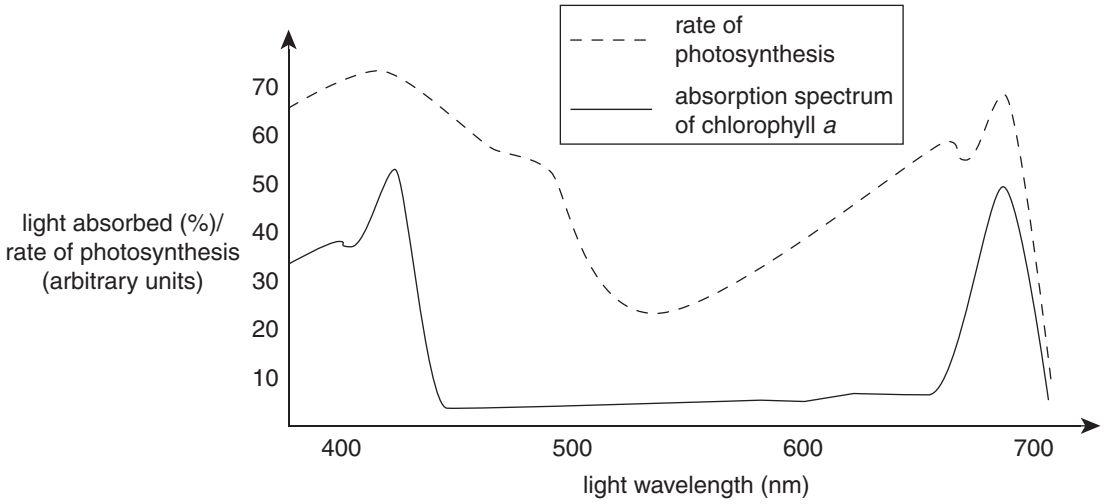
**B.** the rate of photosynthesis increases when the temperature is raised from 20°C to 30°C. This is because the enzymes controlling the Calvin cycle are nearer to their optimal temperature.

**C.** the rate of photosynthesis levels off at point Y because chlorophyll molecules have been denatured by the high temperature

**D.** water availability was the variable limiting the rate of photosynthesis at point Y.

**Question 11**

The graph below compares the absorption spectrum of chlorophyll *a* with the rate of photosynthesis of a plant upon exposure to a range of different light wavelengths.




From this graph, it can be concluded that chlorophyll *a* is not the only pigment involved in photosynthesis.

Evidence that supports this conclusion includes the fact that

**A.** the rate of photosynthesis remains high when the plant is exposed to light wavelengths between 450 nm and 650 nm. The percentage of light absorbed by chlorophyll *a* over these wavelengths is low.

**B.** the rate of photosynthesis is low when the plant is exposed to light wavelengths such as 450 nm. Absorption of light by chlorophyll *a* is higher at these wavelengths.

**C.** the rate of photosynthesis and the percentage of light absorbed by chlorophyll *a* are equal at 700 nm.

**D.** between wavelengths 450 nm and 650 nm, the percentage of light absorbed by chlorophyll *a* is constant.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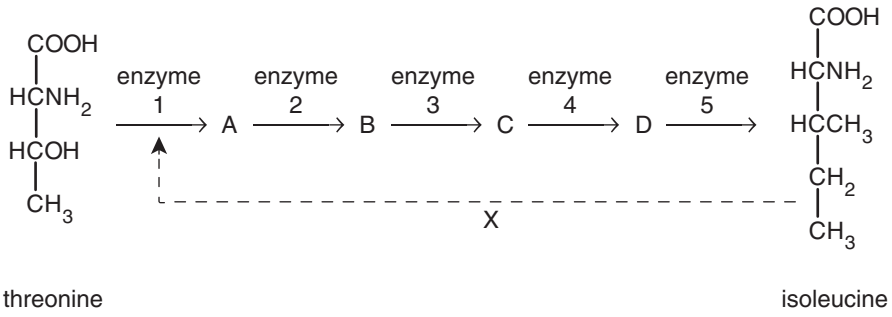
*Use the following information to answer Questions 12 and 13.*

This flowchart below shows the enzyme-controlled conversion of the amino acid threonine into isoleucine.




threonine isoleucine

**Question 12**

The process labelled 'X' is best described as

**A.** non-competitive inhibition.

**B.** denaturation.

**C.** feedback inhibition.

**D.** catalysis.

**Question 13**

To convert threonine to isoleucine in a laboratory, the minimum materials you would need to place into a 'cell-like' solution would be

**A.** enzymes 1–5.

**B.** threonine and enzymes 1–5.

**C.** intermediates A–D and enzymes 1–5.

**D.** threonine and intermediates A–D.

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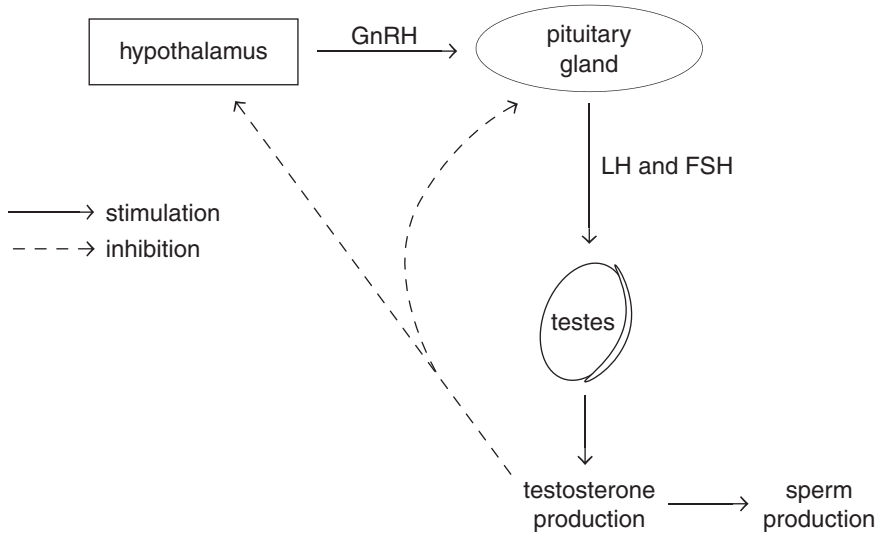
*Use the following information to answer Questions 14 and 15.*

A scientist researching male infertility develops a drug that she thinks might increase sperm production in humans. The control of sperm production is shown in the diagram below.




**Question 14**

Some volunteer male subjects take the drug.

An effective drug may

**A.** lower the levels of gonadotrophin-releasing hormone (GnRH) in the blood.
**B.** increase testis size.
**C.** increase testosterone production, leading to a reduction in sperm formation.
**D.** increase the levels of luteinizing hormone (LH) in the blood.

**Question 15**

In the context of the diagram above, FSH is acting as a(n)

**A.** neurotransmitter.
**B.** pheromone.
**C.** hormone.
**D.** exocrine gland.

**Question 16**

In the mammalian circulatory system, excess fluid remaining in tissue spaces (interstitial fluid) is

**A.** used to form urine.
**B.** removed in the form of sweat.
**C.** drained away by the lymphatic system.
**D.** absorbed by fat cells.

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**Question 17**

A store placed a large basket of fruit containing oranges and unripe bananas by the cash register. There were too many bananas to fit in the basket, so they put the extra bananas in the back room. The next day, the bananas in the basket had ripened, but the ones in the back room had not.

The most likely explanation for this is that

**A.** the heat in the store accelerated the ripening process.

**B.** the oranges released ethylene into the air, triggering the bananas to ripen.

**C.** the oranges released gibberellins into the air, triggering the bananas to ripen.

**D.** auxin in the oranges diffused into the bananas where the two fruits touched each other, triggering the bananas to ripen.

**Question 18**

Phytochrome-deficient mutants of the plant *Arabidopsis thaliana* (mouse-ear cress) are unable to

**A.** control their flowering by detecting changes in day length.

**B.** carry out photosynthesis, due to an inability to absorb light.

**C.** produce antibiotics that kill bacterial and fungal pathogens.

**D.** seal wounds caused by grazing insect pests.

**Question 19**

Most T cells are tolerant to self antigens and become active only when receptors on their membranes are stimulated by non-self antigens. Non-self antigens are recognised by these receptors only when they are exposed on the surface of an antigen-presenting cell (APC).

An example of a cell which can function as an APC is

**A.** a macrophage.

**B.** a B cell.

**C.** a dendritic cell.

**D.** all of the above.

**Question 20**

An experiment was conducted to investigate the role of the pineal gland in controlling reproductive behaviour in mammals. The pineal gland was surgically removed from one group of adult male Syrian hamsters (the *pinx* group). The operation was then faked (incisions made but glands not removed) on another group (the *sham* group).

At the beginning of the study all hamsters had large testes. Each of these two groups was then subdivided and placed under either a long day photoperiod (sixteen hours of light followed by eight hours of darkness) or short day photoperiod (one hour of light followed by twenty-three hours of darkness). After six weeks they weighed the testes of the hamsters and reported the following results.

| | **Long day, *Pinx*** | **Long day, *Sham*** | **Short day, *Pinx*** | **Short day, *Sham*** |
|---|---|---|---|---|
| **Average testis weight (mg)** | 2100 | 2088 | 2077 | 493 |

The best conclusion that can be drawn from these data is that

**A.** the pineal gland secretes hormones that increase testis size in hamsters.

**B.** testis size in hamsters decreases as daylength increases.

**C.** short days are a stimulus for the pineal gland to cause a reduction in testicular size.

**D.** removal of the pineal gland leads to reduced testis size in Syrian hamsters.

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**Question 21**

Consider the following statements regarding avian (bird) influenza.

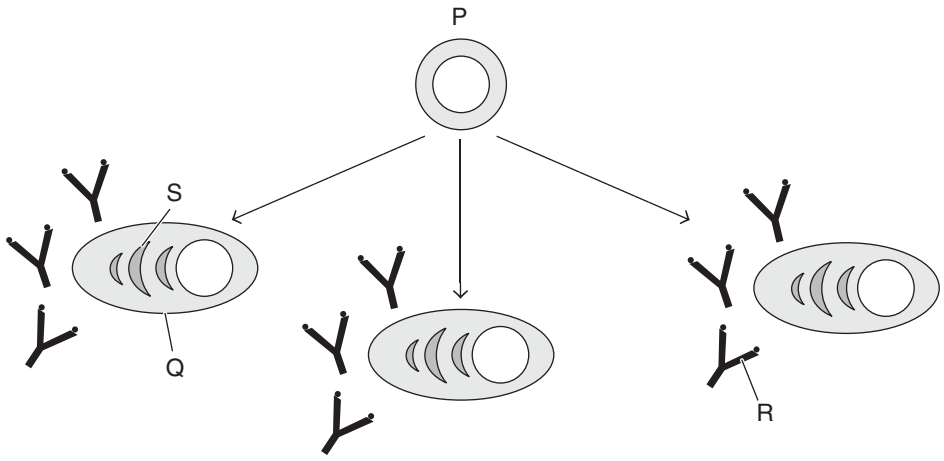
1. The bacterium that causes bird flu is resistant to most antibiotics.
2. The pathogen that causes bird flu may mutate so that it can spread from human to human.
3. The pathogen that causes bird flu is carried by wild birds and can be spread around the world as birds migrate.
4. The pathogen that causes bird flu can be spread by eating cooked chicken.
5. Existing flu vaccines will not work against the type of pathogen that causes bird flu.

The correct statements are

**A.** 1, 2, 3, 4 and 5.
**B.** 1 and 5 only.
**C.** 2, 3 and 5 only.
**D.** 2 and 3 only.

**Question 22**

The diagram below shows an event in the human immune response.




The diagram shows

**A.** antigens (R) from a pathogen (P) causing a B cell (Q) to secrete antibodies (S).
**B.** antigens (S) on a pathogen (Q) causing a B cell (P) to secrete antibodies (R).
**C.** plasma cells (Q) forming antibodies (R) in the endoplasmic reticulum (S), and secreting them in response to a pathogen (P).
**D.** a B cell (P) proliferating into a clone of plasma cells (Q) that secrete antibodies (R) formed in the endoplasmic reticulum (S).

**Question 23**

Individuals with HIV (Human Immunodeficiency Virus) sometimes contract a pneumonia infection that is rare in the rest of the population.

This is because people with HIV

**A.** are unable to fight off these pneumonia-causing organisms.
**B.** are more often exposed to these pneumonia-causing organisms.
**C.** release pheromones that attract the pneumonia-causing organisms.
**D.** release substances that increase the strength of the pneumonia-causing organisms.

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**Question 24**

A **nude mouse** is a mouse that has had its thymus gland removed. The outward appearance of the mouse is a lack of body hair, which gives it the 'nude' nickname.

Nude mice are commonly used in experiments on tissue grafting because

**A.** they have B cells that produce antibodies. The antibodies can then be used to study the process of tissue rejection.

**B.** they are much cheaper than ordinary laboratory mice.

**C.** they have a much less effective immune system due to a greatly reduced number of T cells. Grafted tissue is therefore not rejected.

**D.** the lack of body hair makes them less vulnerable to infections that would lead to an immune response and tissue rejection.

**Question 25**

Salicylic acid is a chemical found in most plants in elevated levels in response to microbial pathogens (it is also found in aspirin). The recent discovery of salicylic acid-binding protein 2 (SABP2) showed how increased levels of salicylic acid can initiate what is being called a type of innate immune response.

When stimulated by raised levels of salicylic acid, SABP2 could play a role in restricting infection within a plant by

**A.** inducing infected areas of the plant to undergo programmed cell death.

**B.** promoting localised cell division in the infected area.

**C.** stimulating less salicylic acid production.

**D.** changing its tertiary structure to no longer be sensitive to salicylic acid.

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## SECTION B: SHORT-ANSWER QUESTIONS

**Instructions for Section B**

Answer this section in **pen**.

Answer all questions in the spaces provided.

### Question 1

Biomacromolecules play a vital role within cells. DNA is a relatively simple molecule, but it provides a blueprint for proteins that are extremely complex in structure. The flowchart below illustrates how these biomacromolecules relate to each other.

DNA → mRNA → protein

**a.** Describe **two** structural features of DNA that enable it to carry out the function depicted in the diagram above.

_____

_____

_____

2 marks

**b.** Use your understanding of protein structure to explain how proteins fold to form a specific **tertiary** structure.

_____

_____

_____

2 marks

Total 4 marks


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**Question 2**

Membranes have a very important role as a selective barrier to movement of chemicals across them.

**a.** Complete the table below by filling in the missing information.

| Type of movement | Membrane component involved | Movement of solutes | Example |
|---|---|---|---|
| active transport | | low to high | absorption of glucose into the blood |
| | protein channels | high to low | the movement of sodium into a cell |
| diffusion | | high to low | the movement of oxygen into a cell |

2 marks

**b.** In some cells, proteins (such as insulin) move from the cytosol to the extracellular environment in membrane-bound vesicles.

**i.** Name this process.

_____

**ii.** Identify the sequence of organelles the protein would pass through from synthesis to secretion.

_____

1 + 1 = 2 marks

**c.** Every membrane is in direct contact with water on either side of it, yet it still provides a structure that acts as an effective barrier.

Use a labelled diagram to show the structure of a membrane, and explain how it can remain stable in such a watery environment.

_____

_____

_____

_____

2 marks

Total 6 marks

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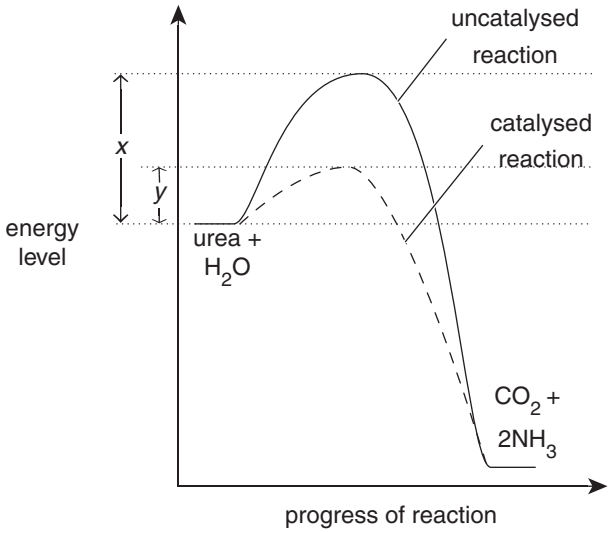
**Question 3**

One of the first enzymes to be purified and studied (in the 1930s) was urease. Urea molecules will slowly break down to carbon dioxide and ammonia in the absence of a catalyst, but the reaction proceeds much more quickly in the presence of urease. This is shown in the figure below.




**a.** Define the term 'enzyme'.

_____

_____

1 mark

**b.** In the graph, why is *x* greater than *y*?

_____

_____

_____

2 marks

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An experiment was performed to test the effect of pH on the activity of urease. Enzyme activity was determined by measuring the amount of urea broken down to $CO_2$ and $NH_3$ per unit time. The table below shows the results of the investigation.

| pH | Enzyme activity (arbitrary units) |
|---|---|
| 4.6 | 0.06 |
| 5.0 | 0.12 |
| 5.6 | 0.32 |
| 6.0 | 0.50 |
| 6.4 | 0.70 |
| 6.8 | 0.88 |
| 7.2 | 0.84 |
| 7.6 | 0.62 |
| 8.0 | 0.40 |
| 8.4 | 0.14 |

**c.** **i.** With reference to the table, what is the most likely optimum pH value for urease?

_____

**ii.** Explain why a change in pH affects the activity of an enzyme.

_____

_____

_____

1 + 2 = 3 marks

**d.** State a factor that must be kept constant during the investigation described above.

_____

_____

1 mark

Total 7 marks

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**Question 4**

Experiments with isolated mitochondria can lead to a better understanding of how they operate.

**a.** **i.** Describe the function of mitochondria.

_____

**ii.** Describe a structural feature of a mitochondrion and show how this feature assists the function of the organelle.

_____

_____

1 + 1 = 2 marks

**b.** One of the important enzymes that operate within mitochondria is pyruvate dehydrogenase (PDH). This enzyme is synthesised in cytoplasmic ribosomes and is then transported to the mitochondrial surface for delivery into the mitochondrion. While it can cross the outer mitochondrial membrane, PDH is excluded from other organelles.

Describe a feature of the outer mitochondrial membrane that allows PDH to cross.

_____

_____

1 mark

**c.** If PDH is prevented from entering the mitochondrion, the Krebs cycle will not function. A build-up of lactic acid in the cytoplasm will result.

**i.** Why is the Krebs cycle called a 'cycle'?

_____

_____

**ii.** Name the process that produces lactic acid in the cytoplasm.

_____

**iii.** Compare the energy output of the process named in part **ii** with that of the process which normally occurs within the mitochondrion.

_____

_____

1 + 1 + 1 = 3 marks
Total 6 marks

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**Question 5**

Many diseases arise from errant molecular interactions or faults in molecular mechanisms at the cellular level. Finding molecules that prevent these interactions or rectify these faults can, in theory, be used to develop drugs to treat such diseases.

**a.** What name is given to this process of drug development?

_____

1 mark

Apples and tea leaves are both rich in molecules called flavonoids that could form the basis for developing new drugs. Between 1985 and 1990, a study was conducted on 805 elderly Dutch men aged between 65 and 84 years who were not previously diagnosed with coronary heart disease. Their dietary intake of flavonoids was varied by controlling their consumption of tea and apples. Death rates and mortality due to coronary disease were also recorded for each group. The results are shown in the following table.

| **Number of men** | 268 | 268 | 269 |
|---|---|---|---|
| **Flavonoid intake (mg/day)** | <19 | 19–30 | >30 |
| **Deaths from coronary heart disease** | 22 | 11 | 10 |

**b.** Using data from the table, what conclusion could be drawn from the results of this study?

_____

_____

1 mark

**c.** How could the conclusion from part **b** be linked to drug development?

_____

_____

1 mark

**d.** Tomato skins contain only trace amounts of flavonoids but contain many molecules that are related to them. Large quantities of a molecule called chalconarigenin are found in the peel of yellow tomatoes. Cells in the petals of petunia (a bedding plant) can convert chalconarigenin into flavonoids via the metabolic pathway below.

$$\text{chalconarigenin} \xrightarrow{\text{chalcone isomerase}} \text{kaempferol (a flavonoid)}$$

Describe what could be done to enable yellow tomatoes to make flavonoids.

_____

_____

1 mark

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**e.** The molecular shapes of kaempferol and adrenaline are similar in some respects. Adrenaline is a neurotransmitter that increases the rate of contraction of cardiac muscle and also causes vasoconstriction. Kaempferol does not have this effect.

Use this information and your knowledge of how neurotransmitters work to explain how kaempferol might work to reduce heart rate and blood pressure in humans.

_____

_____

_____

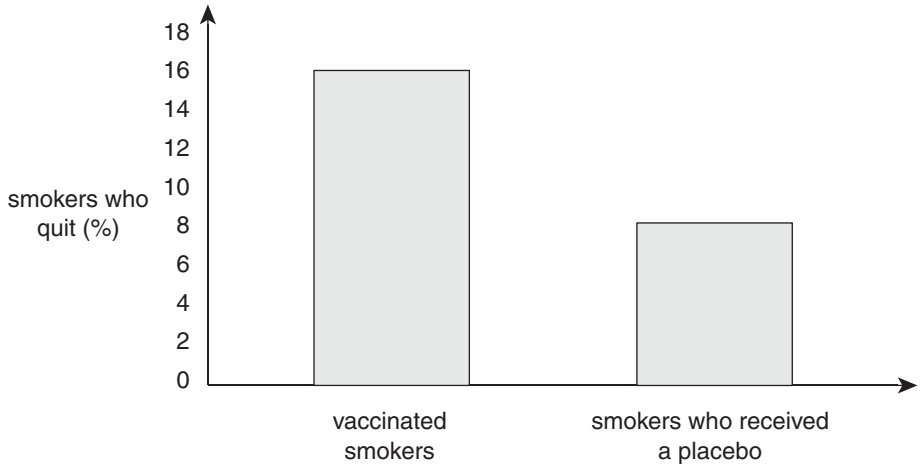
_____

_____

2 marks
Total 6 marks

**Question 6**

Smoking is the world's number one preventable cause of death, killing roughly five million people every year. Extensive research is being conducted to try to find a solution to this problem. The graph below shows the number of people who have quit smoking after having been given an 'anti-smoking' vaccine compared to another group who were given a placebo (an injection of water).




**a.** Identify **two** factors that would need to be kept constant between the groups to ensure sound scientific experimental procedure while generating the above data.

_____

_____

1 mark

**b.** Use the data from the graph to describe the success of the vaccine.

_____

1 mark

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The vaccine promotes an antibody response against nicotine (one of the addictive agents in cigarette smoke). The antibodies then bind to the nicotine which is then unable to enter brain cells to continue causing addiction.

**c.** Identify one of the cell types involved in this process, and describe its role in promoting an antibody response.

_____

_____

2 marks

**d.** Draw and label a diagram of the interaction between nicotine and the antibody.

2 marks
Total 6 marks

**Question 7**

The human thyroid gland is situated in the neck and secretes the hormones thyroxine and calcitonin. Thyroxine causes tissues to generate heat by increasing the rate of aerobic respiration in target cells. Calcitonin helps to regulate blood calcium levels. Thyroxine is lipophilic and calcitonin is water-soluble.

**a.** Describe how thyroxine and calcitonin will differ in the way they deliver their signals to target cells.

_____

_____

_____

_____

2 marks

**b.** Explain how thyroxine may cause responses in a target cell.

_____

_____

_____

_____

2 marks

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**c.** The immune system, which evolved to defend us from invading foreign proteins, normally tolerates (does not develop recognisable responses to) self antigens. However, antibodies to antigens on cells of the thyroid gland exist in up to 36% of adult women. This destroys endocrine cells in the thyroid gland and can result in hypothyroidism.

**i.** What is an 'antigen'?

_____

_____

**ii.** What type of disease does this kind of hypothyroidism represent?

_____

1 + 1 = 2 marks

**d.** Rheumatoid arthritis (which can display similar symptoms to hypothyroidism) is a condition which is often extremely painful due to inflammation of the joints. A corticosteroid (e.g. cortisone) injection can be administered to reduce this inflammation. Cortisone causes vasoconstriction and has antihistamine properties.

Explain how these effects of cortisone will act to reduce inflammation in a joint.

_____

_____

_____

_____

_____

_____

2 marks

Total 8 marks


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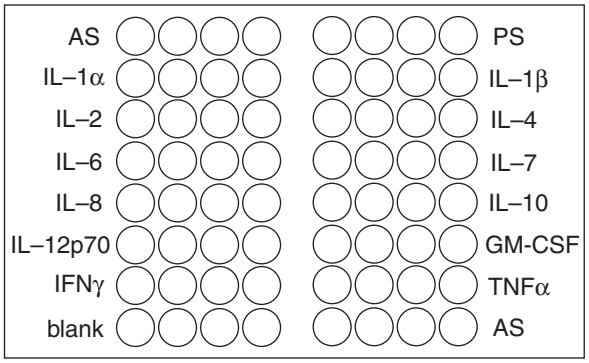
**Question 8**

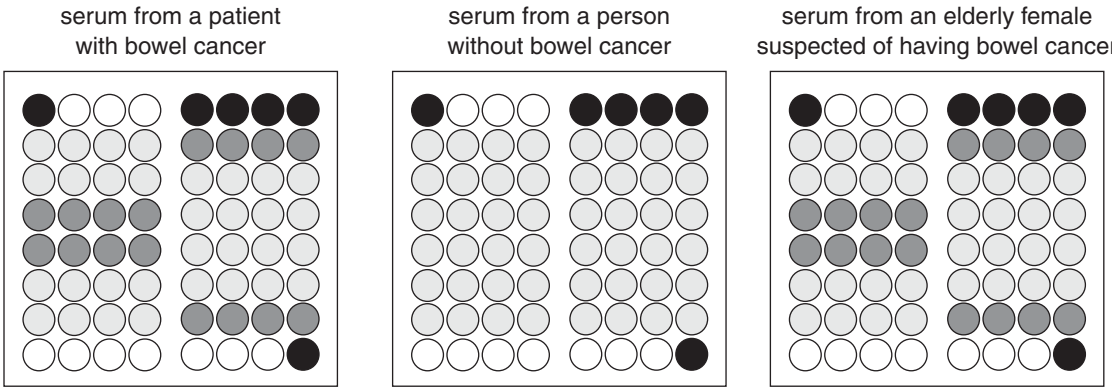
The antibody microarray is attracting a great deal of interest because it can measure protein abundance. There are many applications of this technology, but cancer research is one of the largest and most promising. With increasing use of protein biomarkers in the blood for screening and treatment of cancer, it is important to have a good, quantitative method for measuring and comparing the amounts of particular proteins.

All antibody arrays begin with a number of antibodies bonded to a plate or slide. In a sandwich assay, immobilised antibodies fixed to the slide capture unlabelled proteins from blood serum. A second, labelled antibody is used to detect the bound protein. In the microarray shown below, each slide has sixteen antibodies in sixty-four wells with an identical antibody spotted at the bottom of each row of four wells.




KEY:
**AS** – alignment spots
**PS** – positive control spots
**IL** – interleukin (cytokine)
**GM-CSF** – granulocyte macrophage-colony stimulating factor
**IFN** – interferon
**TNF** – tumour necrosis factor

This sandwich microarray was used to test blood serum from an elderly female. The serum was passed over the microarray. The microarray was then rinsed before being washed with radioactively labelled antibodies. The microarray was rinsed again, then dried, and then placed under photographic film. The images below show the developed film. Dark spots indicate the presence of radioactive antibodies. The darker the spot, the more antibody is present and hence the more serum protein has been bound.




**a.** What is the purpose of the alignment and positive control spots?

_____

_____

_____

2 marks

**b.** Does the elderly female appear to have bowel cancer? Use evidence from the microarrays to support your answer.

_____

_____

_____

1 mark

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**c.** Why were cytokines and interferons detected in the serum from a normal person who has no cancer?

_____

_____

_____

_____

_____

2 marks

**d.** Tumour necrosis factor (TNF) and GM-CSF are hormones. TNF causes tumour cell death and GM-CSF stimulates stem cells to produce macrophages.

**i.** Why is an elevated level of TNF in serum a useful marker for some cancers?

_____

_____

_____

_____

_____

**ii.** Why is an elevated level of GM-CSF in serum a useful marker for some cancers?

_____

_____

_____

_____

_____

_____

_____

_____

1 + 1 = 2 marks
Total 7 marks

**END OF QUESTION AND ANSWER BOOKLET**


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