



T Level Technical Qualification in Health (603/7066/X)

Core knowledge and understanding

Paper B elements 12–13

Paper number: Sample

Specimen 2022

Morning/Afternoon

Time allowed: 2 hours 30 minutes

Student instructions

- Use black or blue ink.
- Fill in the boxes at the bottom of this page.
- Answer **all** questions.
- Read each question carefully.
- You **must** write your responses in the spaces provided. There may be more space than you need.
- You may do rough work in this answer book. Cross through any work you do not wish to be marked.

Student information

- The marks available for each question are shown in brackets. This is to help you decide how long to spend on each question.
- The maximum mark for this paper is 118.
- In questions **6, 7, 12, 18, 19** and **20**, you will be assessed on the quality of your written communication (QWC). Specifically, your ability to:
 - use good English
 - express and organise ideas clearly and logically
 - use appropriate technical terms.
- You may use a calculator.

Please complete the details below clearly and in BLOCK CAPITALS.

Student name _____

Provider name _____

Student number

Provider
number

To be completed by the examiner			
Question	Mark	Question	Mark
1		10 (a)	
2 (a)		10 (b)	
2 (b)		11	
2 (c)		12	
3 (a)		13	
3 (b)		14	
4		15	
5 (a)		16	
5 (b)		17	
6		18	
7		19	
8		20	
9 (a)		21	
9 (b)			
9 (c)			
			TOTAL MARK

Do not turn over until the invigilator tells you to do so.

BARCODE - TQ/HEA/CKU/PAPERB



For the multiple-choice questions, write A, B, C or D in the answer space. Do **not** circle A, B, C or D in the question.

For example:

Answer **C**

If you change your mind about an answer, you **must** put a cross through your original answer and then write your new answer next to it.

For example:

Answer ~~B~~ **B**

Section A: Biology

This section is worth 42 marks plus 6 marks for quality of written communication (QWC).

Answer **all** questions in the spaces provided.

1 Identify the organelle that is only present in plant cells.

[1 mark]

A Centrioles

B Golgi apparatus

C Large vacuole

D Lysosomes

Answer _____

2 (a) **Figure 1** shows some of the features of a microorganism.

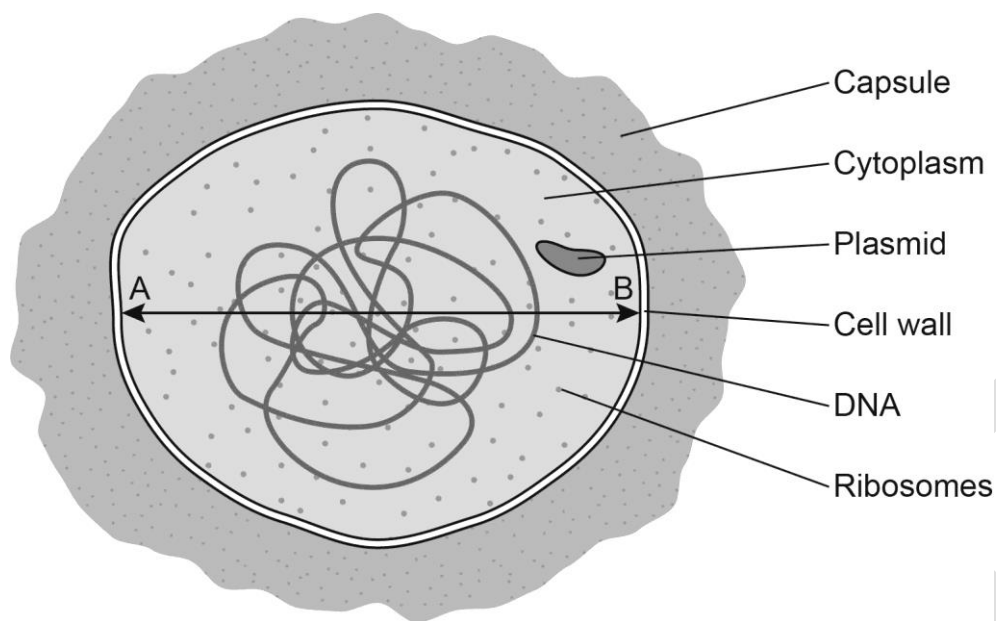


Figure 1: Features of a microorganism

Using the information in **Figure 1**, identify whether this is a prokaryotic or eukaryotic microorganism.

[1 mark]

2 (b) Using **Figure 1**, describe **one** feature which supports your answer.

[2 marks]

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- 2 (c)** The distance between points A and B on **Figure 1** is 90mm, the actual width of the cell is 2 μ m. Calculate the magnification used in the diagram where **1mm = 1000 μ m**.

The equation used to calculate magnification is:

$$\text{magnification} = \frac{\text{size of image}}{\text{size of object}}$$

[2 marks]

- 3 (a)** Alanine is an amino acid.

Two alanine molecules join to form a dipeptide.

Give the name of the reaction which results in the formation of a dipeptide.

[1 mark]

- 3 (b)** A student states that 'the R group of an amino acid is more important than the amine or carboxyl group in producing different types of proteins.'

Evaluate this statement.

[3 marks]

4

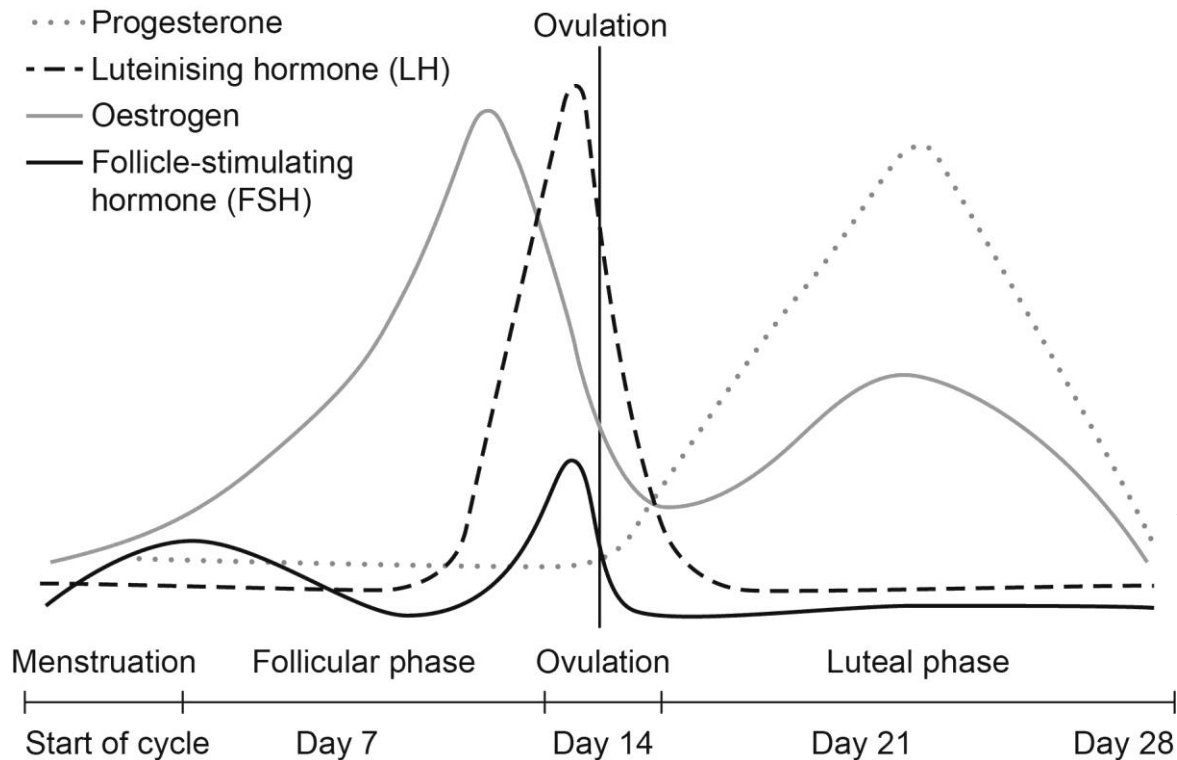


Figure 2: Hormone levels during a menstrual cycle

A student studying **Figure 2** made the following conclusion:

- FSH inhibits oestrogen production and high levels of FSH cause ovulation.

Evaluate to what extent this conclusion can be supported.

Use the information provided in **Figure 2** to support your answer.

[5 marks]

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5 (a) Asthma is a condition that affects the airways of the lungs.

During an asthma attack the muscles in the bronchiole walls contract and excess mucus is secreted. Severe asthma attacks can significantly reduce blood oxygen levels.

Explain **two** reasons severe asthma attacks can cause a reduction in blood oxygen levels.

[4 marks]

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5 (b) Inhalers that deliver medication directly into the lungs are regularly prescribed to patients suffering from asthma. One type of medication used in inhalers are muscle relaxants.

Suggest how this medication can stop an asthma attack.

[2 marks]

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6 **Figure 3** shows the deaths caused by chronic obstructive pulmonary disorder (COPD) per 100 000 deaths in three areas of the United Kingdom.

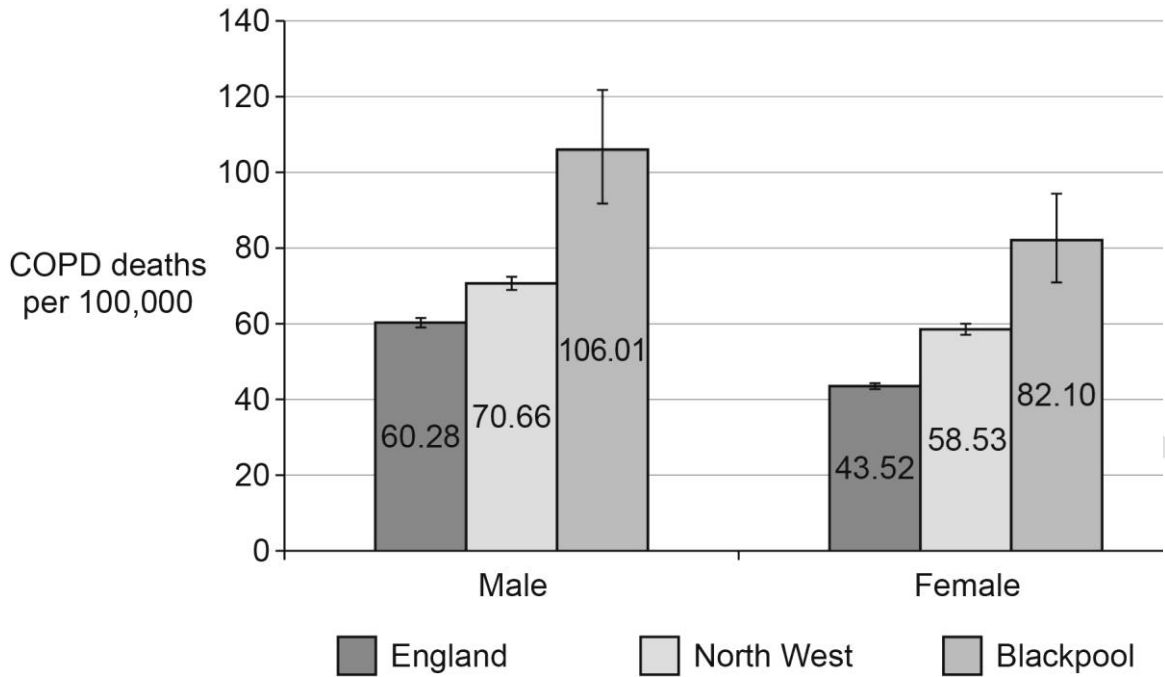


Figure 3: COPD deaths per 100 000

The data was obtained from GP records of patients who were being treated for COPD and was collected between 2017 and 2019.

A trainee data scientist analysed the data shown in **Figure 3** and made the following conclusions:

- the deaths caused by COPD were overall significantly higher for males than females in all areas
- the deaths caused by COPD in Blackpool were significantly higher than the other areas in both males and females
- females in Blackpool are almost twice as likely to die from COPD as females in England
- the higher number of deaths caused by COPD in Blackpool may be linked to high levels of air pollution in Blackpool.

Using your knowledge and understanding of COPD, evaluate the trainee data scientist’s conclusions.

[9 marks, plus 3 marks for QWC]

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7 Vaccines are designed to prevent infection or reduce the seriousness of infection by a specific microorganism.

Most vaccines contain some form of antigen from the microorganism, which is introduced into the body, stimulating immunity to the microorganism.

Vaccines take a long time to develop, are expensive and most vaccines are likely to cause some side effects in some people.

Symptoms of the ‘common cold’ can be caused by over 200 different viruses, many of which are closely related. Frequent spontaneous changes in the viral DNA or RNA sequence can lead to considerable genetic variation of these viruses.

‘It is unlikely that a vaccine against the common cold will be produced for the reasons provided above.’

Using your knowledge and understanding of the human immune system, evaluate this statement.

[12 marks, plus 3 marks for QWC]

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Section B: Chemistry

This section is worth 20 marks plus 3 marks for quality of written communication (QWC).

Answer **all** questions in the spaces provided.

- 8 Identify the standard international (SI) unit used for temperature.

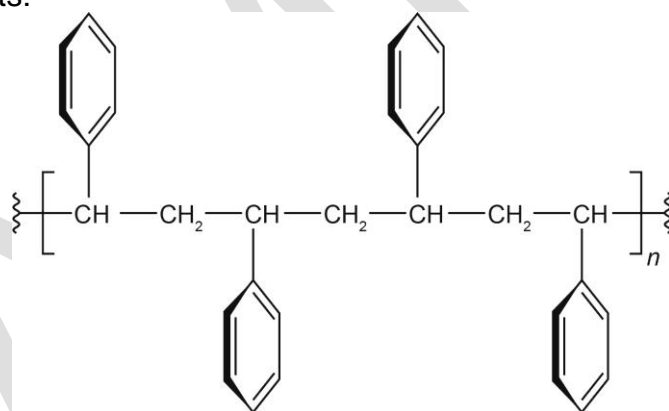
[1 mark]

- A Celsius (C)
- B Fahrenheit (F)
- C Kelvin (K)
- D Rankine (R)

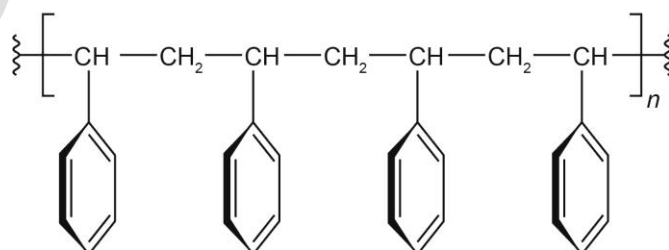
Answer _____

- 9 Polystyrene is a polymer often used in the manufacture of packaging for drugs and as a container for serum and blood tubes.

Two general structures of polystyrene are displayed below along with their melting points:



Structure 'A'
270°C



Structure 'B'
240°C

Figure 4: Two general structures of polystyrene

9(a) Explain how we know polystyrene is a polymer.

[1 mark]

9(b) Give **one** reason why polymers are useful in packaging for drugs and as a container for serum and blood tubes.

[1 mark]

9(c) Explain why structure 'A' has a higher relative strength (or melting point) than that of structure 'B'.

[2 marks]

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10 Typically, polystyrene is produced by polymerisation of styrene (C_8H_8) with an excess of acid (H^+), such as sulphuric acid (H_2SO_4).

The reaction is stopped by adding a suitable base such as sodium hydroxide ($NaOH$).

Sodium hydroxide is formed by reacting sodium (Na) with (H_2O) producing hydrogen gas (H_2).

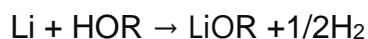
10 (a) Give the balanced symbol equation for this reaction.

[2 marks]

10 (b) Suggest why $NaOH$ is used in excess of H_2SO_4 .

[2 marks]

- 11 The alkali metal lithium (Li) is often incorporated into pharmaceutical compounds. Its reaction with a pharmaceutical compound is shown below:



When scientists perform this reaction with the heavier group 1 metals sodium (Na) and potassium (K), they observe the following reaction rates:

Metal	Rate (gs^{-1})
Li	0.01
Na	0.23
K	0.40

Table 1: Rates of reaction for scheme depicted above, where gs^{-1} = grams per second.

A scientist makes the following statement:

‘Using potassium (K) as the metal is the best course of action as it reacts the fastest.’

Using your understanding of rates of reaction, analyse to what extent the scientist is correct.

[3 marks]

- 12 A company that manufactures hand sanitiser uses ethanol as their main disinfectant. Ethanol can be produced via the hydrolysis of esters. The chemical process of which is detailed below.



A scientist in a laboratory conducts experiments on this type of reaction using different conditions. They obtain the following results:

Reaction conditions	% Yield of product (ethanol)	Rate of reaction (gs ⁻¹)
Room temperature (20°C)	55	1.43
100 °C	65	1.55
Room temperature with catalyst	67	1.89

Table 2: Results from three different conditions of hydrolysis reaction where gs⁻¹ = grams per second.

The scientist then makes the following conclusions:

- heat or a catalyst improves the overall product yield compared to that of normal conditions
- catalysts have a greater effect on the rate of reaction to that of increased temperatures.

Evaluate the scientist’s conclusions.

[9 marks, plus 3 marks for QWC]

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Section C: Physics

This section is worth 20 marks plus 3 marks for quality of written communication (QWC).

Answer **all** questions in the spaces provided.

- 13** Identify which of the following factors determine the force experienced by a magnetic material around a wire that is carrying an electric current.

[1 mark]

- A** The length of the wire
- B** The strength of the current
- C** The thickness of the wire
- D** The weight of the particle

Answer _____

- 14** An experiment is set up whereby an alternating current of 5 A at 230 V with a frequency of 50 Hz is passed through a wire wrapped around an iron core. An iron ball bearing is placed in proximity to the magnet. Upon application of an electric field the iron ball moved towards the magnet.

The same experiment with a direct current at 1 A did not move the ball.

Based on these results, the scientist running the experiment states that only alternating currents can produce an electromagnetic field.

Analyse the scientist's prediction.

[3 marks]

15 State the definition of a wave.

[1 mark]

16 Radium-223 is a radioactive isotope of radium.

152 g of radium-223 is placed in a test tube and left for 33 days.

The amount of radium-223 remaining in the sample is then measured and found to be only 19 g.

Calculate the half-life of radium-223. Show your working.

[2 marks]

17 A 12 V battery discharges through a circuit with a resistance of 4.8 ohms.

Calculate the charge that passes through the circuit over a period of 60 seconds using the formula $I = V / R$ and $Q=IT$.

Show your working.

[4 marks]

Please turn over

18 A hospital radiographer is comparing the imaging techniques of CT and MRI being used to image the pelvis.

The doses of energy transferred to patients that receive each scan are measured and compared for the two techniques.

Scan type	Electromagnetic waves used to image	Scan duration (seconds)	Energy transferred to patient (J / kg)
CT	X-rays	30	0.008
MRI	Radio waves	1800	3000

Table 3: A table to show comparison between MRI and CT scans

These findings are shown in Table 3.

Based upon these observations, the radiographer concludes that CT scans are much safer, as despite X-rays being ionising, less electromagnetic radiation is transferred to the patient, and so should always be used instead of MRI.

Evaluate the radiographer's conclusion.

[9 marks, plus 3 marks for QWC]

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Section D: Biology, chemistry and physics

This section is worth 18 marks plus 6 marks for quality of written communication (QWC).

Answer **all** questions in the spaces provided.

19

Scientists are discussing the health impacts of high levels of radioactivity on the general population.

Details of three isotopes that emit radiation to form new elements known as decay products are shown in **Table 4** below.

Radioactive isotope	Plutonium-241	Iodine-131	Caesium-137
Type of radiation emitted	Beta	Gamma and Beta	Gamma and Beta
Half-life	14 years	8 days	30 years
Decay product	Americium-241	Xenon-131	Barium-137
Half-life of decay product	432 years	Stable	3 minutes
Type of radiation emitted by decay product	Alpha	None	Beta

Table 4: The most significant isotopes released

One scientist states that if samples of the three original radioactive isotopes were found in the air, then:

- iodine-131 poses the greatest danger to the health of the general public in the short term (4 weeks)
- caesium-137 poses the greatest danger over a period of 20 years
- plutonium-241 may account for the greatest risk to health over the longest period.

Using the information in **Table 4** and your knowledge of radiation, evaluate the scientist's statement.

[9 marks, plus 3 marks for QWC]

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20

Humans cannot produce all the essential amino acids needed to make proteins. Therefore, in order to make proteins needed for healthy growth and repair, we need to ensure that these amino acids are present in our diet.

A protein of plant origin and a protein of animal origin have been investigated to find out which amino acids they contained.

Scientists used a protease called pepsin, which is found in the stomach, to breakdown the protein using the following technique:

1. Used a blender to liquidise 10 grams of plant protein in 100ml of distilled water.
2. Added 10ml of the liquidised protein to a boiling tube.
3. Added 1ml of pepsin solution to the boiling tube.
4. Incubated the boiling tube at 37 °C for 15 minutes.
5. Analysed the liquid from the boiling tube using thin layer chromatography to identify any amino acids present.
6. Repeated steps 1 to 5 with the animal protein.

The results are summarised in **Table 5**.

	Protein of plant origin	Protein of animal origin
Total number of different amino acids present	9	8

Table 5: Results from outlined amino acid extraction experiment

A dietician made the following conclusion based on the results:

- more of the protein of plant origin should be present in our diet than the protein of animal origin, as it contains a greater range of amino acids.

Evaluate the dietician's statement.

[9 marks, plus 3 marks for QWC]

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Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Additional specimen assessment materials		November 2022
V2.0	Annual review 2023: Amendment to Q10 to ensure clarity	June 2023	19 June 2023
V2.1	Sample added as a watermark	November 2023	22 November 2023