Q1.

(a)   Describe how you would use cell fractionation and ultracentrifugation to obtain a sample of mitochondria from muscle tissue.

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(4)

(b)   Mitochondrial respiratory capacity is a measure of maximum ATP production in a mitochondrion. Scientists investigated the effect of a resistance exercise training (RET) programme on the respiratory capacity of mitochondria in skeletal muscle tissue. RET develops muscle strength.

The scientists:

*   took samples of muscle tissue from 11 young males before and after a 12-week RET programme
*   recorded the respiratory capacity of the mitochondria in the samples of muscle tissue.

The graph below shows some of the scientists' results.

The error bars represent ± 2 standard deviations from the mean, which includes over 95% of the data.

Using all the information, evaluate whether 12 weeks of RET would improve athletic performance in the general population.

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(5)
(Total 9 marks)

Q2.

(a) Orchids form a large family of flowering plants. Scientists analysed genes coding for ribosomal RNA in orchids.

Explain how this analysis allowed the scientists to determine the phylogenetic relationships between species of orchids.

_____

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(2)

(b) Suggest **one** reason why analysing genes coding for ribosomal RNA allows phylogenetic relationships to be studied between all cellular organisms.

_____

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(1)

(c) Most orchid species are found in tropical rainforests. Two common features found in many of these species are:

- they grow up trees to reach the upper branches
- they only open their stomata at night.

Suggest how each of these **two** features benefits these orchids.

They can reach the upper branches of trees   _____

_____

_____

They only open their stomata at night   _____

_____

_____

(2)

(d)   A student used an optical microscope to observe a piece of tissue from the lower surface of an orchid leaf.

The piece of leaf tissue observed was very thin.

Explain why this was important.

_____

_____

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(2)

(e)   The student produced a biological drawing of the leaf tissue they viewed through an optical microscope.

Give **three** ways the student could ensure they produce a correct biological drawing of the leaf tissue.

Assume the student uses a sharp pencil.

1   _____

_____

_____

2   _____

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3   _____

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(3)
(Total 10 marks)

Q3.

    (a)   Describe how we breathe in.

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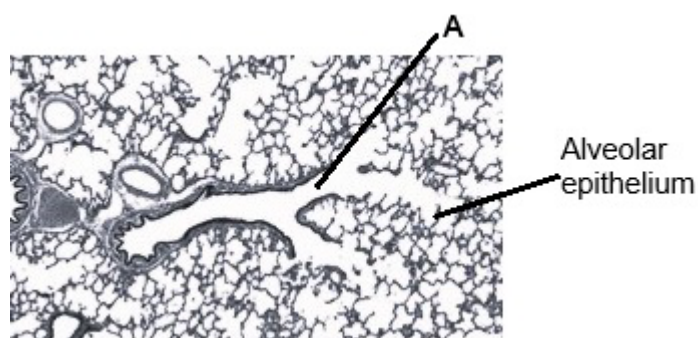
_____

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(3)

    (b)   A scientist prepared alveolar tissue to view using an optical microscope.
The scientist cut very thin slices of the alveolar tissue.

Explain why the scientist used very thin slices of alveolar tissue with the
optical microscope.

_____

_____

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(2)

(c) The figure below is an image of the lung tissue observed using an optical microscope.

Identify the tube labelled **A**.

A _____

The scientist used a ruler to measure the diameter of some of the alveoli.

The table below shows the scientist's results.

Alveolus diameter / mm								
Alveolus diameter / mm	4	2	5	1	2	3	5	2

(1)

(d) The magnification of the image in the figure above is × 40

Use this information and the table above to calculate the mean diameter, in µm, of the alveoli.

Show your working.

Answer _____ µm

(2)

(e)   Give the uncertainty associated with taking a measurement using a ruler
with 1 mm graduations.

Calculate the percentage error for a measurement using the ruler of 4 mm

Uncertainty ±   _____ mm

Percentage error   _____

(2)
(Total 10 marks)

(6)

Q4.

    (a)   Describe and explain how you would use cell fractionation **and** ultracentrifugation to obtain a sample of nuclei from muscle tissue.

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(6)

(b)   Describe the role of organelles in the production and release of enzymes by animal cells.

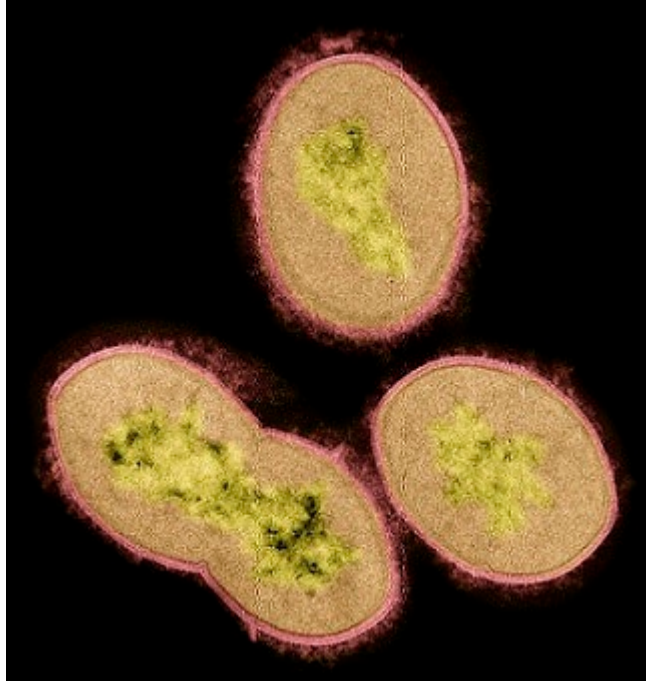Do **not** include details of transcription in your answer.

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(5)

(c)   Describe the structure of ATP.

Outline how named enzymes break down and resynthesise ATP.

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(4)
(Total 15 marks)

Q5.

The figure below shows a transmission electron microscope (TEM) image of three *Streptococcus* bacteria.

(a) Describe how the appearance of the area containing DNA in a TEM image of a eukaryotic cell would differ from that shown in the figure.

_____

_____

_____

_____

_____

_____

(2)

(b) Describe **one** difference between the structure of DNA in a prokaryotic cell and in a eukaryotic cell.

_____

_____

_____

(1)

(c)   *Streptococcus* bacteria can infect the lungs when air is breathed in and
      cause lung disease.

      Describe the mechanism of breathing that causes air to enter the lungs.

      _____

      _____

      _____

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                                                                        (3)

(d)   Some strains of *Streptococcus* bacteria are more likely to cause lung
      disease than other strains.

      Strains that do not cause lung disease are quickly destroyed by
      phagocytes. Phagocytes are stimulated when they bind to murein on
      Streptococcus bacteria.

      Each strain of *Streptococcus* bacteria has a capsule of different thickness
      from the others.

      Suggest how *Streptococcus* bacteria with a thicker capsule are more likely
      to survive **and** so cause lung disease.

      _____

      _____

      _____

      _____

      _____

                                                                        (2)
   **(Total 8 marks)**

Q6.

Scientists investigated the activation of T lymphocytes.

The scientists studied two types of cell:

*   naïve T cells, which are T cells that have not yet been in contact with a foreign antigen
*   activated helper T cells, which are T cells that have been activated by a foreign antigen.

The figure below shows electron microscope images of the two types of cell.
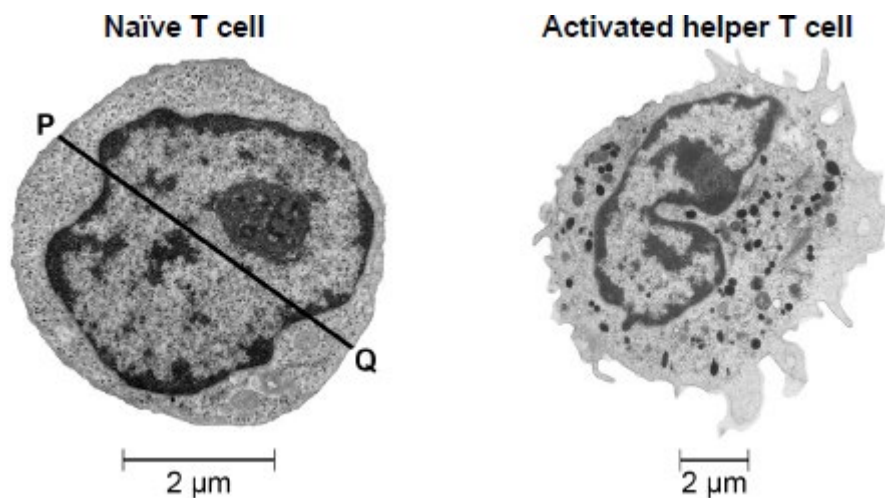
The activated helper T cell has a volume of 463 μm³

(a)   Calculate the volume of the naïve T cell shown in the figure.
Then calculate how many times larger the activated helper T cell volume is compared with the naïve T cell volume.
Assume the cell is spherical.
Use line **PQ** to measure the diameter of the naïve T cell.

Volume of a sphere = $\frac{4}{3}\pi r^3$ where π is 3.14

Show your working.

Volume of naïve T cell   _____ μm³

Number of times larger the activated helper T cell
volume is compared with the naïve T cell volume   _____

(3)

(b)   State **one** feature that shows the images in the figure in part (a) were taken with an electron microscope and **not** an optical microscope.

Explain your answer.

_____

_____

_____

_____

_____

_____

(2)

(c)   State **one** role of a helper T cell.

_____

_____

_____

(1)

(d)   The rate of translation is increased in T cells activated by antigens.

Describe the role of tRNA in translation.

_____

_____

_____

_____

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_____

(2)
(Total 8 marks)

Q7.

(a)   Which statement about the function of ribosomes is correct?

Tick ✓ **one** box.

Site of transcription, catalyse the joining of
amino acids by hydrolysis reactions ☐

Site of transcription, catalyse the joining of
nucleotides by condensation reactions ☐

Site of translation, catalyse the joining of
amino acids by condensation reactions ☐

Site of translation, catalyse the joining of
nucleotides by hydrolysis reactions ☐

(1)

(b)   Name **two** biological molecules that can be coded for by a gene.

Do **not** include a polypeptide or protein in your answer.

1 _____

2 _____

(1)

(c)   Scientists investigated the structure of the endoplasmic reticulum.

The table below shows some of the scientists' results.

Type of endoplasmic reticulum	Percentage of endoplasmic reticulum made of phospholipids
Rough	46.8
Smooth	52.5

Use the data in the table to suggest how the structure of rough endoplasmic reticulum is different from the structure of smooth endoplasmic reticulum **and** how this is related to their functions.

_____

_____

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_____

(3)
(Total 5 marks)

Q8.

(a)   Give the **three** structural features found in **all** virus particles **and** describe the function of **one** of these features.

1   _____

2   _____

3   _____

Function of **one** named feature   _____

_____

_____

_____

(2)

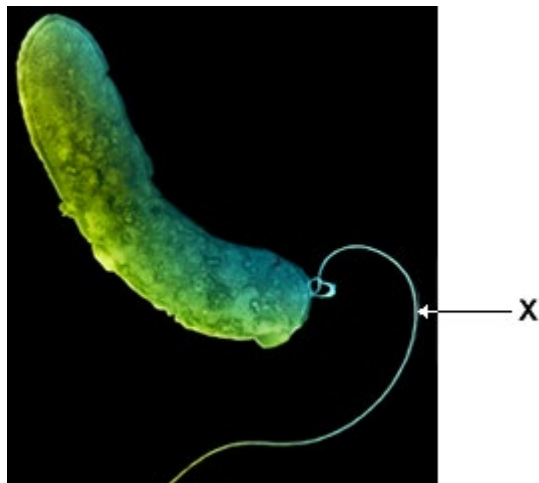(b)   Explain why viruses are described as acellular and non-living.

_____

_____

_____

_____

_____

_____

(2)

(c)   Give **one** reason why antibiotics are **not** effective against viruses.

_____

_____

_____

(1)
(Total 5 marks)

Q9.

(a) The figure below is an image of a bacterium obtained using a scanning electron microscope.

Name the structure labelled **X**.

_____

(1)

(b) The figure above is different from an image of this bacterium obtained using a transmission electron microscope.

Describe and explain **one** difference between these images.

Description   _____

_____

Explanation   _____

_____

(2)

(c) The resolution of an image obtained using an electron microscope is higher than the resolution of an image obtained using an optical microscope.

Explain why.

_____

_____

_____

(1)

(d)   A student determined the size of a cell structure from a photograph
        obtained using a microscope.

        He used a ruler and a calculator and gave the answer in µm

        Describe how the student determined the size of the structure.

        _____

        _____

        _____

        _____

                                                                    (2)

(e)   Name **two** structures found in **all** bacteria that are **not** found in plant cells.

        1   _____

        2   _____

                                                                    (2)

(f)   Name **two** features of HIV particles that are **not** found in bacteria.

        Do **not** include attachment protein in your answer.

        1   _____

        2   _____

                                                                    (2)
                                                        (Total 10 marks)

Q10.

(a)   Describe the structure and function of the nucleus.

_____

_____

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_____

(4)

(b)   Name the main polymer that forms the following cell walls.

Plant cell wall   _____

Fungal cell wall   _____

(1)

Scientists investigated the effect of the number of fungal species in soil on the diversity of plant species.

The table below shows their raw data for soil containing 14 fungal species.

Plant species	Total shoot biomass / g m^{-2}
Poa compressa	2
Achillea millefolium	4
Aster cordifolius	5
Aster novae-angliae	7
Chrysanthemum leucanthemum	15
Daucus carota	36
Fragaria virginiana	51

(c)   Suggest **one** reason the scientists used biomass instead of the number of individuals of each plant species when collecting data to measure diversity.

_____

_____

_____

_____

(1)

(d)   The scientists used this equation to calculate the plant species index of diversity.

$$d = 1 - \sum \left(\frac{n}{N}\right)^2$$

where n = shoot biomass of each plant species
and N = total shoot biomass of all plant species

Use this equation to calculate the index of diversity for the data in the table above.

Index of diversity _____

(2)

(Total 8 marks)