

Genetic information, variation and relationships between organisms – AS Biology P2

1. No.3

03.1

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

[4 marks]

Use a cold, isotonic, buffered solution to prevent enzyme activity, osmosis and pH changes.
Homogenise the muscle tissue to break open cells and filter to remove large debris.
Centrifuge at low speed to separate and remove the heaviest organelles such as nuclei.
Centrifuge the supernatant at a higher speed to pellet the mitochondria.

03.2

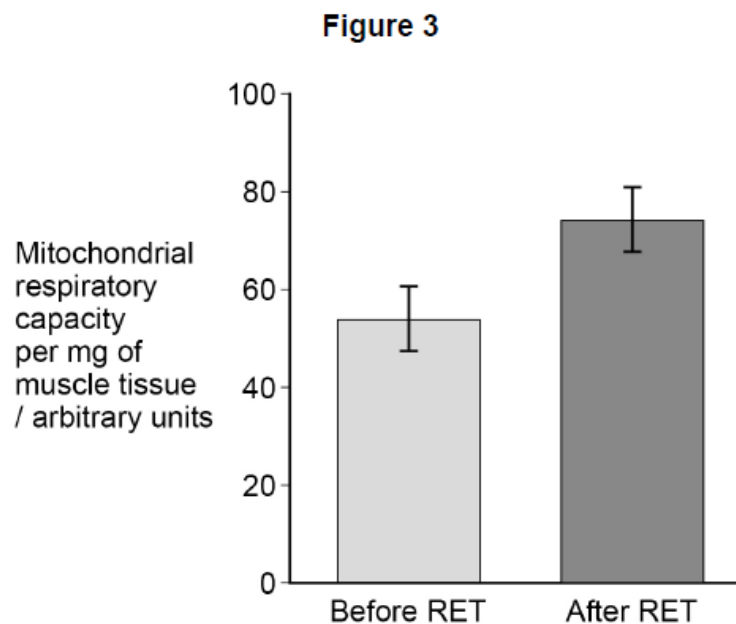
Mitochondrial respiratory capacity is a measure of maximum ATP production in a mitochondrion. Scientists investigated the effect of a resistance exercise training (RET) programme on the respiratory capacity of mitochondria in skeletal muscle tissue. RET develops muscle strength.

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.

Figure 3 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.

[5 marks]

The results show that mitochondrial respiratory capacity significantly increased after 12 weeks of resistance exercise training. This increase means more ATP can be produced by mitochondria which can support more powerful and sustained muscle contraction improving exercise capacity. The study involved 11 participants all young males. This small and unrepresentative sample limits how much findings can be generalised to the wider population including females. Although mitochondrial capacity improved, athlete performance was not directly measured. RET might also not target muscle groups needed for specific sports and activities.

2. No.5

0 5 . 1

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.

[2 marks]

Scientists compared the DNA base sequence of ribosomal RNA genes.
The more similar the sequence, the more closely related orchid species are.

0 5 . 2

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

[1 mark]

All cellular organisms have ribosomes.

0 5 . 3

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.

[2 marks]

They can reach the upper branches of trees to obtain more light for photosynthesis.

They only open their stomata at night to reduce water loss.

0 5 . 4

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.

[2 marks]

The tissue was thin to produce a single or few layers of cells. This allows light to pass through the specimen for clearer observation under optical microscope.

0 5 . 5

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.

[3 marks]

1 Use single continuous lines.

2 Do not use shading.

3 Draw only the outline of tissues.

3. No.7

07.1

Edwards' syndrome is a condition resulting from an extra chromosome 18. A chromosome mutation in the second meiotic division is the most frequent cause of Edwards' syndrome.

Explain how a chromosome mutation in the second meiotic division could result in an extra chromosome 18.

In your answer, name the type of chromosome mutation which would result in the extra chromosome.

[2 marks]

Non disjunction, occurs when sister chromatids fail to separate during the second meiotic division.

07.2

Complete trisomy 18 is the most common type of Edwards' syndrome. This occurs when all the cells of the body have an extra chromosome 18.

Explain why all the cells of the body have an extra chromosome 18.

[2 marks]

The extra chromosome 18 is present in the zygote due to a mutation in the gamete. All body cells are genetically identical because they are produced by mitosis from this original zygote.

07.3

Mosaic trisomy 18 is another type of Edwards' syndrome. This occurs due to a chromosome mutation after fertilisation.

In mosaic trisomy, the body has cells with an extra chromosome 18 and cells with the correct number of chromosomes.

Explain how cells with different numbers of chromosomes are produced in mosaic trisomy.

[1 mark]

Cells with correct number of chromosomes are produced from cells without mutation.

07.4

The age of the female parent is a factor linked to the risk of a child having Edwards' syndrome.

Which statistical test should be used to test whether this link is statistically significant?

Tick (✓) **one** box.

[1 mark]

Correlation coefficient

☒

Chi-squared

☐

Student's t-test

☐

07.5

A ventricular septal defect (VSD) is a common feature of Edwards' syndrome.

A VSD is a hole in the wall between the two ventricles of the heart. A VSD can cause higher blood pressure in the lungs.

Explain how a VSD can cause higher blood pressure in the lungs.

[2 marks]

More blood flows from the left ventricle to the right ventricle because the left ventricle has higher pressure due (to its thicker muscular wall). This results in a greater volume of blood being pumped to the lungs, causing higher pressure in the pulmonary artery.

4. No.9

09.1

Describe the role of haemoglobin (Hb) in the loading, transport and unloading of oxygen.

[5 marks]

Haemoglobin loads (binds) oxygen in the lungs where oxygen concentration is high. This occurs at a high partial pressure of oxygen.

Binding of the first oxygen molecule changes the shape of haemoglobin, making it easier for more oxygen molecules to bind. This is called cooperative binding.

Oxygen is transported in the blood as oxyhaemoglobin with the red blood cells.

Haemoglobin unloads oxygen in respiring tissues where it is needed.

This unloading occurs at low partial pressure of oxygen which promotes oxygen release.

09.2

Describe how a polypeptide is produced by translation of mRNA.

[5 marks]

mRNA attaches to a ribosome.
tRNA molecule binds to mRNA; their anticodons are complementary to the codons on mRNA. Each tRNA carries a specific amino acid. Peptide bonds form between adjacent amino acids. This process uses ATP to form peptide bonds. After donating its amino acid, the tRNA is released and can be reused. The ribosome moves along the mRNA, allowing the next tRNA to bind continuing polypeptide formation.