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Activity

Mycorrhizal fungi: the great connectors

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Introduction

Use information from Bethan Manley's article, *Mycorrhizal fungi: the great connectors*, and your own knowledge to answer the following questions.

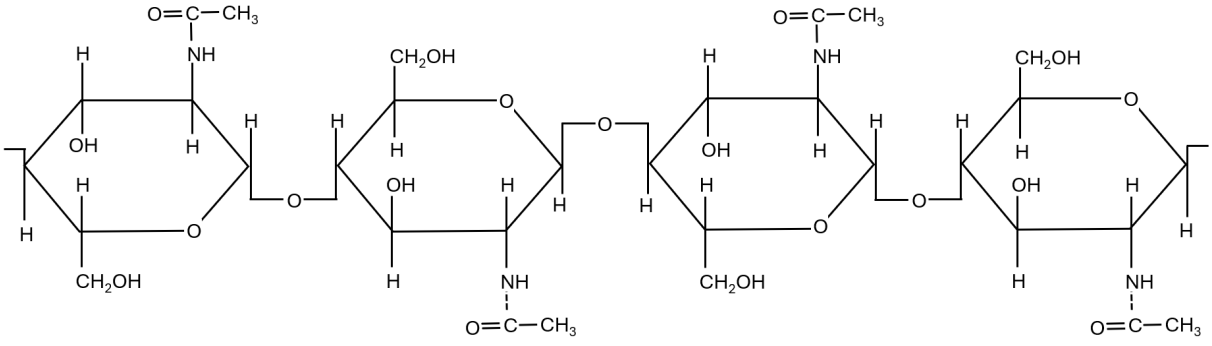
Questions

1 At the beginning of the article, three eukaryotic kingdoms are named.

a Name the biological domain into which these kingdoms are classified. [1 mark]

b Name **two** other domains used in the biological classification system. [1 mark]

2 Figure 1 below represents part of the polysaccharide that forms the bulk of the cell wall of a fungus.



a Name the polysaccharide that is represented in Figure 1. [1 mark]

b The bulk of a plant cell wall is made of the polysaccharide cellulose. Give one way in which the structure of the molecule represented in Figure 1 is:

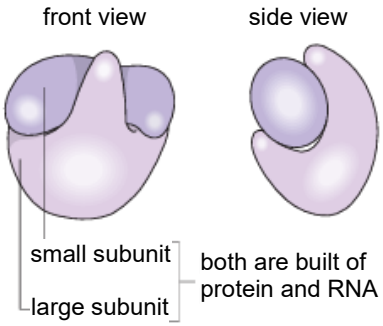
i similar to that of cellulose

ii different from that of cellulose [2 marks]

3 The article describes how a mycorrhizal fungus obtains its nutrients.

Describe how a free-living (non-mycorrhizal) filamentous fungus obtains its nutrients from the soil. [3 marks]

4 Figure 2 below shows the structure of a eukaryotic ribosome.



a A eukaryotic ribosome is described as an 80S ribosome. What does the unit 80S represent? [1 mark]

b The non-coding ribosomal RNA within the ribosome is encoded by ribosomal DNA (rDNA) within the genome. This rDNA contains many base sequences that have been maintained over vast evolutionary time.

i Name the process by which non-coding ribosomal RNA is produced from rDNA. [1 mark]

ii Suggest the advantage of base sequences in the rDNA being maintained over vast evolutionary time. [2 marks]

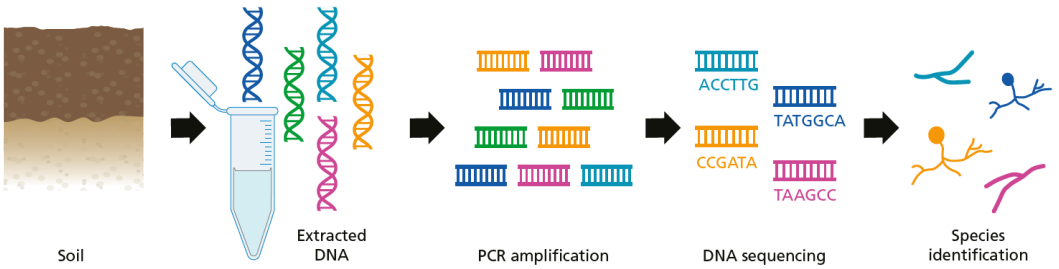
5 'According to recent research, mycorrhizal fungi are capable of moving 13 billion tonnes of carbon into the soil from plants every year.' 13 billion can be represented as 13×10^9.

The Earth's surface area is estimated to be 510×106 km^2. Of this area, 70.8% is covered by oceans.

a Use this information to calculate the mean mass of carbon moved into the soil each year by fungi. Give your answer in tonnes km^{-2}, and to three significant figures. [2 marks]

b Give and explain **two** reasons why this mean value might be an inappropriate way of representing carbon capture by fungi. [2 marks]

6 Figure 3 of the article is replicated below.



a Describe the process of PCR amplification. [4 marks]

b Outline how the process of DNA sequencing allows species identification from a sample of environmental DNA (eDNA). [3 marks]

Model answers

1 **a** Eukarya

b Archaea and bacteria

2 **a** Chitin

b i The monomers are joined by β1,4 bonds in Figure 1 and in cellulose.

ii The C2 in each monomer has a hydroxyl/OH group in cellulose but a nitrogen-containing group in Figure 1.

3 Any three from:

- Fungal ribosomes produce protease, peptidase, amylase, disaccharidase and lipase.
- Fungus secretes digestive enzymes into the soil.
- Extracellular digestion/digestion in soil produces amino acids, monosaccharides, fatty acids and glycerol/micelles.
- Fungus absorbs products of digestion using active transport/co-transport.

4 **a** Sedimentation rate

b i Transcription

ii Maintains structure of ribosomes so essential cell proteins continue to be produced.

5 **a** Correct answer of 87.3 tonnes km^{-2} = 2 marks

If above answer not given, 1 mark for any one of the following:

Working shows $13 \times 10^9 \div 148.92 \times 10^6$

OR

Answer shows correct calculation of 13 × 109 ÷ incorrect value of area

OR

Answer is correct but with more than three significant figures, e.g. 87.29(5192)

b Any two from:

- Not all land is covered by soil, so no mycorrhizal activity in these land areas.
- (Regional) differences in temperature of soil will affect rate of mycorrhizal enzyme activity.
- (Regional) differences in soil pH will affect rate of mycorrhizal enzyme activity.
- Waterlogged soil will lack sufficient oxygen for aerobic activity of mycorrhizae.

6 **a** Separate double-stranded DNA by heating to ~ 95°C.

Cool to ~ 40°C to allow primers to attach to (3') end of single-stranded DNA.

Add (heat-tolerant) *Taq* polymerase and nucleotides and heat to ~ 72°C.

Repeat the above cycle of events (at least ten times).

b Use data base to find base sequence(s) unique to target species.

Produce/buy labelled DNA fragments with complementary base sequence.

When mixed together, any labelled DNA in the eDNA sample indicates the presence of the target species.