

This paper is the Intermediate Biology Olympiad 2024.

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Some questions may have been altered or removed compared to the version of this paper used during the competition period. This is a download of an online, interactive paper, so the formatting is also sub-optimal.

Students are not expected to have memorised all the facts assessed, or be familiar with all the topics presented. Their biological intuition and problem solving is being assessed.

Answers are not provided.*

* Mark schemes are not provided as these papers do not resemble typical revision aids. Each topic is bespoke to a particular year. Students can use the papers as inspiration and should complete their own research to enhance their understanding. We also provide the papers here to ensure all students have access to them, whereas no one outside of UKBC has access to mark schemes.



Intermediate Biology Olympiad 2024

This was one 60 minute paper.

You may use a calculator.

It is recommended that you have a pen and paper to hand for rough work.

No marks are subtracted for incorrect answers.

Some questions have more than one answer you need to choose. For some questions, you need to put the answers in the correct order.

Award	Percentage score	Percentage of students who took part
Gold	68.96%	5%
Silver	64.57%	10%
Bronze	60.09%	15%
Highly Commended	57.92%	15%
Commended	55.25%	15%





Duration: 60 minutes Total marks: 92

Question 1

Part 1 of 3

Roots are plant organs that typically serve to anchor the plant and collect water and nutrients. However, there are many different types of roots specialised to different environments. Evolution is beautiful!



Part 2 of 3

What type of roots are in the pictures?

6 marks

Groups Aerating root (helps respiration)

Buttress root (for support)

Diffuse root

Photosynthetic root

Root nodule (for symbiotic bacteria)

Storage root



Put into the groups above a) D

b) B

- c) C
- d) A
- e) E
- f) F

Part 3 of 3 True or false?

5 marks

Mark the following as TRUE or FALSE

a) The specialised structure of root A houses mycorrhizal fungi to increase the nutrient absorption of the plant.

TRUE FALSE

b) Root B has tiny pores that allow the plant to take up water and air.

TRUE FALSE

c) Plants with root D are typically found in environments where the soil is shallow and nutrient poor.

TRUE FALSE

d) Root E is typically only found in gymnosperms (pine trees etc).

TRUE FALSE

e) Root F is a form of root aiming to provide structural support to the plant in climates with frequent rain.

TRUE FALSE



Part 1 of 4

Sort the following plant types into groups. The only plant with a picture is the avocado, the rest must be determined only from their names.

5 marks

Groups Eudicots(floweringplants with 2seed leaves)

Gymnosperms(pine trees etc)

Magnoliids(primitiveflowers)

Monocot(floweringplants with 1 seed leaf)

Other

Put into the groups above

- a) ferns
- b) sunflower
- c) larch
- d) ginkgo
- f) wheat
- e) avocado



Part 2 of 4 Here are some microscopy images of plant tissues.





Part 3 of 4 What part of the plant are the images from?

5 marks

Groups Leaf

Bud (shoot meristem)

Root

Stem

Seed

Put into the groups above a) G

- b) D
- c) F
- d) B
- e) E
- f) A
- g) C

Part 4 of 4

True or false

4 marks





Mark the following as TRUE or FALSE

a) C shows a microscopy image of the photosynthetic organ of the plant.

TRUE FALSE b) Cell division is taking place in the structure in image B.

TRUE FALSE c) The plant in image C is well watered.

TRUE FALSE

d) The plant in image G is probably drought resistant.

TRUE FALSE



Part 1 of 8

Plants use a green pigment called chlorophyll. What do you know about chlorophyll?

3 marks

Mark the following as TRUE or FALSE a) Chlorophyll is found in both cyanobacteria and the chloroplasts of plants.

TRUE FALSE

b) Brown algae are brown because they use a brown pigment to produce their food.

TRUE FALSE

c) Plants produce their own food by a process called photosynthesis.

TRUE FALSE

d) Carnivorous plants, like the Venus fly trap, do **not** have chlorophyll.

TRUE FALSE

e) Some moulds are green because fungi have chlorophyll.

TRUE FALSE

Part 2 of 8

Sadly, not all plants stay green forever. The leaves of deciduous plants change colour before falling in autumn. The figure below shows the mean RGB (red green blue) pixel values of leaves on different days of the year in three deciduous plant species. The grey rectangle shows the window of time where leaves visibly changed their colour.





Part 3 of 8

Using the figure above, select whether the statements are True or False.

5 marks

Mark the following as TRUE or FALSE

a) Deciduous trees may reabsorb some nutrients from their leaves before they lose their foliage.

TRUE FALSE

b) Leaves of these plants change their colour during autumn mostly because of chlorophyll degradation.

TRUE FALSE



c) The leaves of *Q. lyrata* are noticeably more blueish than the other plants at day 300.

TRUE FALSE

d) *F. grandifolia* is the latest to change its leaf colour.

TRUE FALSE

e) The change in mean RGB values observed in leaves of all 3 species is due to an increased production of anthocyanin (red pigment).

TRUE FALSE

Part 4 of 8

Unripe bananas and plantains are green because their peel is filled with chlorophyll. Chlorophyll degradation causes the colour change of the bananas' and plantains' peels when they ripen.



https://foodandremedy.com/blog/plantain-vs-banana/

Part 5 of 8

The image below shows how the banana peel and the plantain peel changes colours when it ripens at different temperatures. The colours on the y axis are provided using CIELAB colour values:* L = the lightness value* a = determines the colour on green-red scale, where <0 values are more towards green and >0 values are more towards red* b = determines the colour on the blue-yellow scale, where <0 values are more towards blue and >0 values are more towards blue





Part 6 of 8

Using the figure above, and your knowledge, select whether the statements are True or False.

4 marks

Mark the following as TRUE or FALSE a) The plant hormone ethylene is responsible for banana ripening.

TRUE FALSE

b) By the end of the experiment, the peel of bananas ripened at 20°C is more yellow than the peel of bananas ripened at 30°C.

TRUE FALSE



c) The lightness of the peel of both plantains and bananas are the same at day 6 of the experiment.

TRUE FALSE

d) The chlorophyll in plantain peel degrades quicker than in banana peel at 30°C.

TRUE FALSE

Part 7 of 8

Although the colour green is prominent in nature, not everyone perceives it the same way. People with red-green colour blindness have difficulty differentiating between the two colours. For example, if you're colour blind, you may not see the '5' in the circle below.



Part 8 of 8

Using **only the pedigree below*<mark>*, decide i</mark>f the following statements are True or False:





5 marks

Mark the following as TRUE or FALSE

a) The mutation causi<mark>ng red-gre</mark>en colour blindness is on the Y-chromosome.

TRUE FALSE

b) Red-green colour blindness is recessive.

TRUE FALSE

c) The mutation causing red-green colour blindness may be on an autosome (chromosomes other than the sex chromosomes X and Y).

TRUE FALSE

d) *All* affected individuals *must* carry 2 red-green colour blindness alleles.

TRUE FALSE e) Individual I./2 is a carrier for red-green colour blindness.

TRUE FALSE

f) Individual III./1 is a carrier for red-green colour blindness.

TRUE FALSE

g) There is a 2:1 chance that individual III./5 is heterozygous for red-green colour blindness.



TRUE FALSE

h) If individual III./4 were to have a child with an unaffected individual, none of their children could be born with red-green colour blindness.

TRUE FALSE

i) The relatedness of individuals IV./1 and IV/2 is 12.5%.



Part 1 of 4

The nature of this tale is simple: oak trees grow and produce leaves. Herbivorous insects eat the oak leaves. Insectivorous birds eat the insects.Scientists studied this ecosystem to look at how birds can affect the growth of oaks:* Some trees were left alone as controls, with no intervention ("Control"). * Some trees had a cage around them that kept birds out, but let the herbivorous insects in ("Cage"). * Some trees were sprayed with insecticide ("Spray").Figures A) and C) show the density of leaf chewer insects throughout 1989 and 1990. Asterixis (*) show a statistically significant difference between groups.Figures B) and D) show the total insect numbers summed over the season of 1989 and 1990, respectively. Bars with different letters are statistically significantly different from each other.





Part 2 of 4

True or false?

4 marks

Mark the following as TRUE or FALSE

a) The scientists counted the insects in 1989 and 1990 on the same number of days.

TRUE FALSE

b) Leaf chewer density did **not** change through the growing season in 1989.

TRUE FALSE

c) The treatment of the trees did not have a significant difference on leaf chewer density on the 22nd of August in 1989.

TRUE FALSE

d) The leaf chewer density observed on control oak trees was significantly higher at the beginning of the 1989 growing season compared to the beginning of the 1990 growing season.

TRUE FALSE

e) Total insect density is the lowest on trees that were treated with insecticide.

TRUE FALSE

f) Total insect density is the highest in trees which were inaccessible to birds.

TRUE FALSE

Part 3 of 4

The scientists also collected data on leaf damage and biomass. Bars with different letters are statistically significantly different from each other. Bars with a shared letter are not significantly different from each other.





Part 4 of 4 True or False?

4 marks

Mark the following as TRUE or FALSE a) Using insecticide likely reduced the population of birds.

TRUE FALSE

b) There was *no* significant difference in twig biomass under any treatment.

TRUE FALSE

c) The trend in twig biomass suggests hunting birds and destroying their nests may lead to smaller oak trees.

TRUE FALSE



d) Leaf biomass may be lower in caged oak trees because more leaf area is eaten.

TRUE FALSE

e) Leaf biomass may be lower in caged oak trees because they have less energy to sprout new leaves.

TRUE FALSE



Part 1 of 7

1 cm $^{*}3^{*}$ of solution X is mixed with an equal volume of 5% sodium hydroxide solution in a test tube. When two drops of 1% copper sulphate solution are added, a purple colour is produced. What does solution X contain?

1 mark

- *Choose ONE* a) Amino acids
- b) Lipids
- c) Polysaccharides
- d) Proteins
- e) Glucose

Part 2 of 7 Which of the following statements applies to meiosis, but not to mitosis?

1 mark

Choose TWO a) Chromosomes separate on a spindle

- b) Chromosomes occur in pairs called bivalents
- c) Chromosomes split into chromatids
- d) Alleles are swapped between chromosomes
- e) Chromosomes attach to spindle via centromeres

Part 3 of 7

Which of the following processes involves the net conversion of ATP to ADP and P *~i*:

1 mark

Choose ONE

- a) Binding of haemoglobin and oxygen to give oxyhaemoglobin
- b) Synthesis of proteins from amino acids
- c) Production of CO *~2* from acetyl CoA
- d) Production of pyruvic acid from glucose
- e) Transfer of electrons from photosystem II to photosystem I in photosynthesis

Part 4 of 7



Which of the following formulae represents a lipid?

1 mark

Choose ONE

a) $C_{12}H_{22}O_{11}$

- b) NH₄NO₃
- c) C₅₇H₁₁₆O₆
- d) NH₂CH₂COOH
- e) CH₃COCOOH

Part 5 of 7

Removal of the source of carbon dioxide from photosynthesizing chloroplasts results in rapid changes in the concentration of certain chemicals. Which row shows the correct combination of concentration changes?

	ΑΤΡ	Ribulose biphosphate	Phosphoglyceric acid
Α	Decreases	Increases	No change
В	Increases	Increases	Decreases
С	Increases	No change	Increases
D	No change	Decreases	Decreases
Ε	Increases	Decreases	Decreases
2 marks Choose ONE			

a) A

2

- b) B
- c) C
- d) D
- e) E

Part 6 of 7

Which of the following substances is the main energy buffer in skeletal muscle cells?

2 marks

Choose ONE a) Urea

b) GTP



- c) Haemoglobin
- d) Creatine phosphate
- e) ATP
- f) ADP
- g) Glucose

Part 7 of 7 The secretion of cortisol:

1 mark

Choose TWO a) shows circadian rhythm in humans.

- b) is decreased during periods of stress.
- c) increases sex hormone function.
- d) is correlated with epinephrine / adrenaline.



Part 1 of 4

Enzymes are very important in biology: they make reactions occur more quickly. Enzyme inhibitors are compounds that stop enzymes from working! Let's take a look at the different types of inhibitors.

Part 2 of 4 True or false

4 marks

Mark the following as TRUE or FALSE a) Irreversible inhibitors may bind to the target enzyme with covalent bonds.

TRUE FALSE

b) Competitive inhibitors bind to the enzyme at the same site as the substrate.

TRUE FALSE

c) Allosteric / non-competitive inhibitors bind to the substrate.

TRUE FALSE

d) Competitive inhibitors often structurally resemble the substrate of the enzyme.

TRUE FALSE e) An enzyme can be inhibited by a change in its tertiary structure.

TRUE FALSE

Part 3 of 4

Receptors in the human body are proteins that help different cells communicate with each other.

Part 4 of 4 True or False?

4 marks

Mark the following as TRUE or FALSE a) Receptors are **only** found on the plasma membrane.

TRUE FALSE

b) Neurons use receptors to transmit electrical signals at the synapse.

TRUE FALSE c) Botulinum toxin, found in botox, prevents the release of neurotransmitters in the neuromuscular junction.

TRUE FALSE

d) Some steroid (hydrophobic) receptors may be transcription factors.

TRUE FALSE

e) Receptors for hydrophilic molecules often phosphorylate cytoplasmic proteins which trigger changes in the cell.

TRUE FALSE





Part 1 of 4

Three Floridian ants share a habitat:- *Formica*, the acid-spraying collector ant- *Polyergus*, the slave-raider ant- *Odontomachus*, the trap jaw ant



By Johnsonwang6688 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=60144184

Part 2 of 4 True or false?

3 marks

Mark the following as TRUE or FALSE a) Ants typically moult when they are growing.

TRUE FALSE b) Ants may form a social group, where each caste is specialised for a certain task.

TRUE FALSE c) All ants are herbivores - they only eat plant material.

TRUE FALSE d) The shell of ants is made of the same material as the cell wall of mushrooms.

TRUE FALSE

Part 3 of 4

* *Polyergus* are obligate social parasites.* *Polyergus* kidnap *Formica* and force the latter to raise their 'younglings'.* *Formica* collect severed *Odontomachus* heads.* The chemicals on the cuticles (surface) of *Formica* and *Odontomachus* ants from the same regions are very similar. There is no change in their interaction if *Formica* and *Odontomachus* from different regions are brought together.





By The photographer and www.AntWeb.org, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=8153313

Part 4 of 4 True or false?

4 marks

Mark the following as TRUE or FALSE a) An obligate parasite cannot survive without the host species.

TRUE FALSE b) *Formica* are predators of *Odontomachus*.

TRUE FALSE c) Mimicry is the phenomenon where individuals of different species are similar to each other.

TRUE FALSE d) *Formica* are disguising themselves as *Odontomachus* to be more effective hunters.

TRUE FALSE e) *Formica* may be disguising themselves as *Odontomachus* hide from *Polyergus*.

TRUE FALSE



Part 1 of 2

The diagram represents a pyramid of energy which shows energy loss from the food chain to decomposers, upward transfer of energy to the next trophic level, and energy loss through respiration.True or false?



4 marks

Mark the following as TRUE or FALSE a) Food chain efficiency is about 10%.

TRUE FALSE

b) The energy of the final trophic level is not utilised.

TRUE FALSE

c) Plants have a lower respiratory loss than animals.

TRUE FALSE

d) Energy loss to respiration is higher than to decomposers

TRUE FALSE

Part 2 of 2

If N represents population size, r represents the difference in per capita birth rates and death rates, K represents the carrying capacity, t represents time, which of the following equations best describes logarithmic growth of the population?

3 marks

Choose ONE a) dN/dT = rN

- b) dN/dT = rNK
- c) dN/dT = r(K-N)
- d) dN/dT = N([K-N]/rK)







Part 1 of 1

Sort the following life forms into groups!



Sketch of tree of life by Darwin 6 marks Groups Fish

Crustaceans

Marsupials

Placental Mammals

Other

Put into the groups above a) Kangaroo

- b) Bat
- c) Human
- d) Barnacle
- e) Shark
- f) Whale
- g) Horseshoe Crab



- h) Possum
- i) Platypus
- j) Seahorse
- k) Crayfish



Part 1 of 4

Which of the animal groups (phyla) below do **not** contain bilaterally symmetrical organisms?



By Paulo Neis - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5095837 1 mark

Choose ONE

- a) Vertebrates (Chordata)
- b) Roundworms (Nematoda)
- c) Jellyfish (Cnidaria)
- d) Insects (Arthropoda)
- e) Earthworms (Annelida)

Part 2 of 4

Which of the following features **cannot** be used to describe reptiles?

2 marks

Choose as many as appropriate a) Dry scaly skin

- b) Warm blooded
- c) Eggs with yolk and leathery shell
- d) Heterodont teeth
- e) Internal fertilisation



Part 3 of 4

The following features describe a group of plants:- They have large fronds which are true leaves.- The dominant sporophyte generation is diploid.-Meiosis occurs in sporangia found in sori under the fronds.- The gametophyte generation is represented by a prothallus.Which group is being described?

1 mark

Choose ONE a) Ferns (Filicinophyta)

b) Club Mosses (Lycopodophyta)

- c) Horsetails (Sphenophyta)
- d) Liverworts (Hepaticae)
- e) Conifers (Coniferophyta)

Part 4 of 4

Mesoderm tissue is absent in:

1 mark

Choose ONE a) Jellyfish (Cnidaria)

- b) Snails (Mollusca)
- c) Flies (Insecta)
- d) Starfish (Echninodermata)
- e) Crabs (Crustacea)

