Grade 11 Biology Model Paper 1

ANSWER KEY

Full marks 75 · 3 hours

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

A practice paper by Science Playground, made to CDC's Specification Grid 2077, Grade 11 Biology (Bio. 201); not an official CDC or NEB paper.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

a. **(iii)** So much energy is lost at each step that too little is left to support another level.

b. **(ii)** 1971

c. **(iv)** Their seeds die if they are dried or frozen.

d. **(iii)** Ichthyology

e. **(ii)** 32%

f. **(ii)** Local people go on living and farming inside it and help to run it.

g. **(iv)** Mollusca

h. **(ii)** It became cloudy with microbes within days.

i. **(ii)** analogous organs, because they do the same work but are built differently and arose separately

j. **(iii)** A few mosquitoes were already resistant; they survived and bred, so their resistance spread.

k. **(iv)** It is wrong: humans and chimpanzees are cousins, both descended from a common ancestor that lived millions of years ago.

Group B Short answers, each on one content area — 40 marks

Question 2 — 5 marks

a. *Pinus* has **long shoots** (branches of unlimited growth, with a bud at the tip) and **dwarf shoots** (branches of limited growth, only a few millimeters long). **[2]**

The green needles (foliage leaves) grow **only on the dwarf shoots**: each dwarf shoot with its bundle of needles is a spur.

Marking scheme

- Long shoots (unlimited growth) and dwarf shoots (limited growth).
- Needles grow only on the dwarf shoots.

b. **[2]**

- The pine lower down, with long slender needles **three** to a spur, is **chir pine**, *Pinus roxburghii* (खोटे सल्लो), the pine of the subtropical hills (about 500 to 2,000 m).
- The pine higher up, with soft blue-green needles **five** to a spur, is **blue pine**, *Pinus wallichiana* (गोब्रेसल्लो), the pine of the temperate mountains.

The number of needles in a spur is fixed for each species, which is what tells them apart.

Marking scheme

- Three needles to a spur, lower down: chir pine (*Pinus roxburghii*).
- Five needles to a spur, higher up: blue pine (*Pinus wallichiana*).

c. **No.** A fruit develops from an ovary. In *Pinus* the ovules lie **naked** on the ovuliferous scales, with no ovary round them, so no fruit can form: the woody cone is a cluster of scales (sporophylls) round an axis, and the seeds lie bare on the scales. **[1]**

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Marking scheme

- No: the ovules are naked on the scales with no ovary, so no fruit forms; the cone is a group of seed-bearing scales.

OR

a. [2]

- **Rhizoids**: unicellular, colorless threads that **fix** the thallus to the ground and **absorb** water and minerals.
- **Scales**: multicellular, purple or violet, in rows beside the midrib; they **protect the growing point** and hold water against the lower surface.

Marking scheme

- Rhizoids: fix the thallus and absorb water and minerals.
- Scales: protect the growing point / hold water.

b. The discs are **gemmae**, made in the gemma cups. Each gemma has a growing point in a **notch on each side**, and each notch grows into a thallus, so **one gemma grows into two plants**, which soon separate. [2]

A gemma is only a piece of its parent, made by mitosis, so the plants from a male thallus's gemmae are all **male**.

Marking scheme

- Gemmae; one gemma grows into two plants (one from each notch).
- Male, because a gemma is a vegetative piece of its parent.

c. *Marchantia* is **dioecious**: each thallus is male or female. Plants grown from the gemmae of one thallus are all of the **same sex**, so the patch has only antheridia or only archegonia. With no egg to fertilize (or no antherozoids to fertilize it), no zygote forms, and without a zygote there is no sporophyte. [1]

Marking scheme

- All plants are of one sex (dioecious, from one parent's gemmae), so no fertilization and no zygote, hence no sporophyte.

Question 3 — 5 marks

a. Yeast belongs to the **Ascomycota** (Ascomycetes, the sac fungi), and its sexual spores are **ascospores**, formed inside an ascus. [1]

Marking scheme

- Ascomycota (sac fungi), with ascospores.

b. He is seeing **budding**, the commonest vegetative reproduction of yeast in a sugar solution. A small outgrowth, the **bud**, grows from the parent cell; the nucleus divides, one daughter nucleus passes into the bud with some cytoplasm, a wall forms across the narrow neck, and the bud separates, leaving a bud scar. [2]

When yeast grows fast the buds bud again before they separate, giving a temporary chain of cells, the **pseudomycelium** (false mycelium).

Marking scheme

- Budding: an outgrowth grows, the nucleus divides and one nucleus passes into the bud, which separates.
- The chain is a pseudomycelium.

c. [2]

- **Yeast X** has a **haplobiontic** life cycle (as in *Schizosaccharomyces octosporus*): the **haploid** phase is dominant, and the zygote turns straight into an ascus and undergoes meiosis.
- **Yeast Y** has a **haplodiplobiontic** life cycle: the haploid and diploid phases are **equally** important, both living and budding for many generations. This is the life cycle of *Saccharomyces cerevisiae*, Ankit's baker's yeast.

Marking scheme

- X: haplobiontic, haploid phase dominant.

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- Y: haplodiplobiontic, both phases equal; this is baker's yeast, *S. cerevisiae*.

Question 4 — 5 marks

a. Any two of these: **[2]**

- **Aerenchyma**, tissue with large air spaces, in the stems, leaf stalks and leaves: it stores oxygen and carbon dioxide, carries oxygen to the roots in mud poor in oxygen, and makes the plant buoyant (the swollen leaf stalk of water hyacinth).
- **Mechanical and vascular tissues (xylem) are poorly developed**, since the water holds the plant up and supplies water to every part.
- The **cuticle is absent or very thin** in submerged parts, so water and gases pass in easily.
- **Stomata are absent** in submerged leaves, and only on the **upper surface** of floating leaves, facing the air.

Marking scheme

- One anatomical adaptation explained (e.g. aerenchyma for buoyancy and air).
- A second one explained (e.g. little xylem and sclerenchyma; thin or no cuticle; stomata absent or upper surface only).

b. It is a **xerophyte**, adapted to **dry** places. The thick cuticle and the **sunken stomata**, where still, moist air is trapped in the pit, both cut the loss of water by transpiration. **[1]**

Marking scheme

- Xerophyte (dry habitat); thick cuticle and sunken stomata reduce water loss.

c. **[2]**

- *Opuntia* is built to **store water and lose little**: fleshy water-storing tissue, a thick cuticle and few, sunken stomata, which open only at night. Watered every day, it takes in far more water than it can lose, and its waterlogged tissues and roots, short of oxygen in soggy soil, **rot**.
- *Hydrilla* is a **submerged** hydrophyte: it has little or no cuticle and poor roots and xylem, because water always surrounds it. In air and sun water escapes freely from its whole surface, while its weak roots and xylem can't replace it, so it **dries up**.

Marking scheme

- *Opuntia*: adapted to store and save water, so daily watering waterlogs and rots it.
- *Hydrilla*: thin or no cuticle and poor roots and xylem, so out of water it loses water it can't replace and dries.

Question 5 — 5 marks

a. The **generation time** is the time taken for a bacterial population to **double** (for one cell to divide into two). **[2]**

The phase is the **lag phase**, when the bacteria are active but not yet dividing.

Marking scheme

- Generation time: the time for the population (one cell) to double.
- Lag phase.

b. In 4 hours there are $\frac{4 \times 60}{30} = 8$ generations. Each doubles the number, so **[2]**

$$N = 100 \times 2^8 = 100 \times 256 = 25{,}600 \text{ bacteria}$$

Marking scheme

- 8 generations in 4 hours.
- $100 \times 2^8 = 25{,}600$ bacteria.

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c. The strong salt raises the **osmotic pressure** outside the bacteria: water is drawn **out** of their cells, so they can't grow and divide (and many die). **[1]**

Marking scheme

- Salt draws water out of the bacteria (high osmotic pressure), so they can't grow.

Question 6 — 5 marks

a. **Innate** behavior is inborn: it is inherited and done correctly the first time, without practice. **Learned** behavior is gained through experience during life, and changes with it. **[1]**

Marking scheme

- Innate is inherited and needs no experience; learned is gained through experience.

b. **[2]**

- Earthworms move **away** from light: **negative phototaxis**.
- *Euglena* moves **towards** moderate light: **positive phototaxis**.

Marking scheme

- Earthworms: negative phototaxis.
- *Euglena*: positive phototaxis.

c. Pulling the hand away is a **reflex action**. Receptors in the finger start impulses that travel along a **sensory neuron** to the **spinal cord**, where an interneuron in the gray matter passes them straight to a **motor neuron**; the motor neuron makes the arm muscles contract and the hand moves. This short path, the **reflex arc**, doesn't go through the brain. **[2]**

The message also travels **up the spinal cord to the brain**, which is a longer path, and only when it gets there does she **feel** the pain, a moment after her hand has already moved.

Marking scheme

- The withdrawal is a reflex through the spinal cord (receptor, sensory neuron, interneuron, motor neuron, muscle), not waiting for the brain.
- Pain is felt only when impulses reach the brain by a longer route, so after the hand has moved.

Question 7 — 5 marks

a. The three kinds are the **pharyngeal**, **integumentary** and **septal** nephridia. **[2]**

The pharyngeal nephridia lie as three pairs of tufts in segments **4, 5 and 6**.

Marking scheme

- Pharyngeal, integumentary and septal nephridia.
- Pharyngeal nephridia in segments 4, 5 and 6.

b. Each segment of the body has about 200–250 integumentary nephridia on its body wall, but each segment of the **clitellum** has about **2,000–2,500**, ten times as many, crowded like the trees of a forest. **[1]**

Marking scheme

- The clitellum's segments carry about 2,000–2,500 integumentary nephridia each, far more than other segments.

c. **[2]**

- **Collecting.** A septal nephridium has a **nephrostome**, a ciliated funnel open to the coelom, whose cilia draw in **coelomic fluid** with its wastes (it also takes wastes from the blood). Integumentary nephridia have **no nephrostome** (they are closed) and take their wastes **only from the blood**.
- **Pouring out.** Septal nephridia pour their wastes **into the gut** through the excretory canals and ducts (**enteronephric**); integumentary nephridia open straight **outside** through tiny nephridiopores on the skin (**exonephric**).

Marking scheme

- Septal: open nephrostome draws in coelomic fluid; integumentary: closed, take wastes only from the blood.

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- Septal: enteronephric (into the gut); integumentary: exonephric (out through the skin).

OR

a. [2]

- The **macronucleus** (large, bean-shaped) controls the **metabolism**, the cell's daily activities: it is the vegetative nucleus.
- The **micronucleus** (small, spherical, diploid) controls **reproduction**: it divides by mitosis in fission and by meiosis in conjugation.

Marking scheme

- Macronucleus: controls metabolism (daily life of the cell).
- Micronucleus: controls reproduction.

b. [1]

The six to ten radiating canals **collect the extra water** from the cytoplasm all round and pour it into the central contractile vacuole, which then contracts and empties it to the outside through its pore (osmoregulation).

Marking scheme

- They collect excess water from the cytoplasm and pour it into the contractile vacuole.

c. [2]

- **Without its micronucleus**, the *Paramecium* goes on living, feeding and swimming for a time, and can even divide by fission for a while, because the **macronucleus runs its daily life**. But it can't take part in **conjugation**, so its line can't mix genes or renew its macronucleus, and in the end it grows old and dies out.
- **Without its macronucleus**, the cell **soon dies**, because nothing is left to control its metabolism.

Marking scheme

- No micronucleus: lives for a time on the macronucleus, but can't conjugate, so its line dies out.
- No macronucleus: dies soon, as metabolism is no longer controlled.

Question 8 — 5 marks

a. [3]

- *Planaria*: phylum **Platyhelminthes** (flatworms); **acoelomate**, with no body cavity: the space between body wall and gut is filled with parenchyma.
- *Ascaris*: phylum **Aschelminthes** (roundworms); **pseudocoelomate**, its cavity lined by mesoderm only on the outer side.
- **Earthworm**: phylum **Annelida** (segmented worms); **coelomate**, with a true coelom lined by mesoderm on both sides (a schizocoel).

Marking scheme

- *Planaria*: Platyhelminthes, acoelomate.
- *Ascaris*: Aschelminthes, pseudocoelomate.
- Earthworm: Annelida, true coelom (eucoelomate).

b. [2]

No. The body cavity makes a real difference to how the animal lives. A fluid-filled coelom between the gut wall and the body wall:

- lets the **gut move and grow independently** of the body wall, and gives room for organs;
- acts as a **water-filled (hydrostatic) skeleton** that the muscles push against, which lets the earthworm burrow;
- **carries substances** round the body in its fluid.

A flatworm, packed solid with tissue, has none of these.

Marking scheme

- One advantage of the coelom (e.g. gut moves independently of the body wall, room for organs).
- A second advantage (e.g. hydrostatic skeleton for burrowing; carries substances).

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Question 9 — 5 marks

a. Characters that an organism **acquires during its life**, by using or not using a part of its body in answer to its needs, are **passed on to its young**; over many generations such changes build up into new forms. **[1]**

Marking scheme

- Characters acquired during life by use and disuse are inherited by the offspring.

b. It shows that a change made to the **body** during life is **not inherited**: cutting the tails changed the body cells, not the germ cells (eggs and sperm), so the young were born with normal tails. Acquired characters are not passed on, against Lamarck. **[1]**

Marking scheme

- Changes to body cells in life are not inherited (only germ cells pass characters on), so the inheritance of acquired characters is disproved.

c. **[3]**

- **Lamarck:** short-necked ancestors stretched their necks to reach the leaves of tall trees when the low leaves ran short; each one's neck grew a little longer by the stretching, and its young were born with the longer neck. Over many generations of stretching, the long neck was made.
- **Darwin:** necks already **varied** in every herd. In dry seasons, when low leaves ran short, giraffes with longer necks reached higher leaves, survived better and left more young, which inherited long necks. Over many generations the average neck became longer: **natural selection** of inherited variation.
- **Darwin's** explanation is supported. A change made by stretching is a change in the body cells and is not inherited (Weismann's experiment), while inherited variation and the survival of the fitter are seen in every population.

Marking scheme

- Lamarck: stretching lengthened each neck, and the acquired longer neck was inherited.
- Darwin: necks varied; those with longer necks survived and bred more, passing them on (natural selection).
- Darwin's is supported, since acquired characters are not inherited while inherited variation is.

Group C Long answers, each on one content area — 24 marks

Question 10 — 8 marks

a. **[2]**

$$\text{Br or Ebr } \% \ ♀ \ K_{(5)} \ C_{1+2+(2)} \ A_{(9)+1} \ \underline{G}_1$$

The corolla is **papilionaceous** (butterfly-like): one standard (vexillum), two wings (alae) and two keel petals joined into the keel (carina).

Marking scheme

- Floral formula: % ♀ K(5) C1+2+(2) A(9)+1 G1 (superior).
- Papilionaceous corolla.

b. i. **Diadelphous stamens**: the ten stamens are in **two bundles**, nine with their filaments joined into a sheath round the ovary and one free, written (9) + 1. **[3]**

ii. **Marginal placentation**: the ovary has one chamber made of one carpel, and the ovules are borne in a row along the **margin** where the edges of the carpel are joined.

iii. **Legume** (pod): the fruit of one carpel that, when ripe, splits along **both** its seams to set the seeds free.

Marking scheme

- Diadelphous: stamens in two bundles, (9) + 1.
- Marginal: ovules along the joined edge (margin) of a single carpel in a one-chambered ovary.
- Legume: a pod from one carpel that splits along both seams.

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c. The roots of lentil, like those of other members of Fabaceae, carry **root nodules** that hold nitrogen-fixing bacteria, ***Rhizobium***. The bacteria **fix nitrogen** from the air into compounds the plant can use. **[3]**

When the lentil's roots and leftover stems **decay** in the field, those nitrogen compounds are left in the **soil**, so the next crop of rice finds more nitrogen and needs less nitrogen fertilizer. Wheat has no such nodules and adds nothing.

To make the most of it he can **grow legumes in rotation** with rice and wheat, plough the lentil's roots and stubble back into the soil, or grow a legume such as dhaincha and **dig it in as green manure**.

Marking scheme

- Legume roots have nodules with *Rhizobium*, which fix atmospheric nitrogen.
- Decaying roots and stubble leave the nitrogen compounds in the soil, so the following rice needs less fertilizer (wheat adds none).
- A sensible use: crop rotation with legumes, ploughing in the residue, or green manuring (e.g. dhaincha).

OR

a. **Conjugation** is the fusion of the **entire contents of two vegetative cells** (the gametangia), which act as gametes, to form a zygospore. **[2]**

It is **isogamous** because the two fusing gametes are **alike in form** (neither has flagella and both look the same), although one moves and the other stays.

Marking scheme

- Conjugation: fusion of the whole contents of two vegetative cells acting as gametes.
- Isogamous: the two gametes are alike in form.

b. Sample P shows **scalariform** (ladder-like) conjugation, between two different filaments: **[3]**

1. Two filaments of different strains come to lie side by side, and the facing cells put out small outgrowths, **papillae**, towards each other.
2. The papillae grow and touch; the walls between their tips are dissolved by an enzyme (cytase), forming a hollow **conjugation tube**. The joined filaments look like a ladder.
3. The protoplast of each cell of one filament (the male) contracts and moves through the tube into the facing cell of the other filament (the female), where it **fuses** with that protoplast to form a diploid **zygospore**.

Marking scheme

- Scalariform conjugation, between two filaments; papillae grow from facing cells.
- The papillae meet and their walls dissolve to form conjugation tubes (a ladder).
- The male protoplasts pass through the tubes and fuse with the female ones to form diploid zygospores.

c. Sample Q shows **indirect lateral conjugation**, between two **adjacent cells of the same filament**, which meet through a lateral tube round the septum between them. **[3]**

- **Filaments:** in P two filaments take part; in Q only **one**.
- **Empty cells:** in P every cell of the "male" filament is left empty and all the zygospores are in the other filament; in Q **every second cell** of the one filament is empty, and the cells between hold zygospores.
- **Strains:** P's species is **heterothallic** (two different strains, in two filaments, must meet); Q's is **homothallic**, both kinds of gametangium in one filament.

Marking scheme

- Q: indirect lateral conjugation, between adjacent cells of one filament.
- In P two filaments, one left wholly empty; in Q one filament, every second cell empty.
- P is heterothallic (two strains); Q is homothallic (one filament).

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Question 11 — 8 marks

a. Any three of these: **[3]**

Mitosis	Meiosis
Takes place in body (somatic) cells, as in a root tip	Takes place in the reproductive cells that form gametes or spores
One division, giving **two** daughter cells	Two divisions, giving **four** daughter cells
Chromosome number stays the same (2n → 2n): equational	Chromosome number is halved (2n → n): reductional
No pairing of homologous chromosomes and no crossing over	Homologous chromosomes pair and cross over in prophase I
Daughter cells are identical to the parent	Daughter cells differ from the parent and from each other

Marking scheme

- One correct difference.
- A second correct difference.
- A third correct difference.

b. Dividing cells: $45 + 15 + 6 + 12 = 78$. **[3]**

$$\text{mitotic index} = \frac{78}{600} \times 100\,\% = 13\,\%$$

The fraction of cells in a stage is the fraction of the cycle that stage takes. The cycle is 18 h = 1,080 minutes.

- Prophase: $\frac{45}{600} \times 1080 = 81$ minutes.
- Anaphase: $\frac{6}{600} \times 1080 = 10.8$ minutes, about 11 minutes.

Marking scheme

- Mitotic index = $78/600 \times 100\% = 13\%$.
- Prophase = $45/600 \times 1{,}080$ min = 81 minutes.
- Anaphase = $6/600 \times 1{,}080$ min $\approx$ 11 minutes.

c. **No.** Interphase is not a resting stage: during it the cell **grows** and makes proteins (G_1), **copies its DNA** so that each chromosome has two chromatids (S), and makes the materials needed for division (G_2). Without this work no mitosis could follow. **[2]**

Since 522 of 600 cells (87%) are in interphase, interphase takes **87% of the cycle**, about $0.87 \times 18 \approx 15.7$ hours: it is by far the longest part of the cycle.

Marking scheme

- Not resting: the cell grows, replicates its DNA (S phase) and prepares for division.
- 87% of cells in interphase, so it takes about 87% of the cycle ($\approx$ 15.7 h), much the longest stage.

Question 12 — 8 marks

a. The **sinus venosus** (on the back) and the **truncus arteriosus** (on the front). **[1]**

Marking scheme

- Sinus venosus and truncus arteriosus.

b. Both auricles open into the ventricle through one **auriculo-ventricular aperture**, guarded by a valve of **four flaps**, whose free edges hang into the ventricle. They let blood pass from the auricles into the ventricle. **[2]**

The **chordae tendineae** are tough threads of connective tissue that tie the flaps to the ventricle's wall. When the ventricle contracts, they stop the flaps from being pushed back into the auricles (like the strings of

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a parachute), so blood **can't flow back** into the auricles.

Marking scheme

- One auriculo-ventricular aperture with a valve of four flaps, letting blood from the auricles into the ventricle.
- Chordae tendineae hold the flaps so they don't turn back when the ventricle contracts: no backflow.

c. Postcaval vein → **sinus venosus** → (sinu-auricular aperture) → **right auricle** → (auriculo-ventricular aperture) → **ventricle** → **truncus arteriosus** (conus arteriosus, its cavum pulmocutaneum) → **pulmocutaneous arch** → **pulmonary artery** → lungs (its other branch, the cutaneous artery, goes to the skin). **[2]**

Marking scheme

- Postcaval → sinus venosus → right auricle → ventricle.
- Ventricle → truncus arteriosus → pulmocutaneous arch → pulmonary artery → lungs.

d. **[3]**

- **The old (classical) view** (Brücke, 1852): the blood hardly mixes. Deoxygenated blood stays on the right of the ventricle, oxygenated on the left, kept apart by the spongy **columnae carneae**; the **spiral valve** in the conus sends the deoxygenated blood (out first) to the lungs and skin, the mixed blood to the body, and the oxygenated blood to the head.
- **The modern view** (Foxon and others, 1950s, following blood by X-rays): there is **much more mixing** than that, and the spiral valve sorts little. Measurements of oxygen show the truth in between: blood going to the lungs and skin has **less oxygen** than blood going to the body and head, so there is **partial separation**.
- **Why it serves the frog:** the frog is cold-blooded and needs much less oxygen than a mammal or bird; and its **skin** also takes in oxygen, so even the blood returning to the heart from the body has some oxygen (under water, much of the blood can bypass the lungs altogether).

Marking scheme

- Old view: little mixing; columnae carneae and spiral valve sort the blood into the three arches.
- Modern view and measurements: much mixing, but blood to the lungs and skin has less oxygen than to the body: partial separation.
- A frog's low oxygen need (cold-blooded) and skin breathing make partial mixing good enough.

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