REAL-LIFE BIOLOGY

Life on Earth

Teacher guide

For the National 5 Biology workbook



C. Blewis

Blewis LEARNING

Using the workbooks

The National 5 Biology workbook for **Life on Earth** has six topics. Every topic has learning pages, a practical the learner plans and evaluates, a brain break and an exam-style check-up.

PRACTICALS

Learners plan each investigation (variables, prediction, kit, risk, method), take repeat readings, work out averages, draw graphs with their own scales, and write conclusions and evaluations.

PRACTICAL SAFETY

Every practical has a Stay safe table and a teacher note with hazards, adapted versions and common problems. The Stay safe tables and these notes are a starting point, not a complete risk assessment: the teacher or school must risk assess every practical for their own learners, room and kit before use, following their employer's policies and national guidance (in Scotland, SSERC). Always check learners' care plans and medical information. Activities with flames or microbes are teacher demonstrations, with example results provided.

NO LAB, NO KIT, OR A LEARNER ABSENT

Each practical includes example results so learners can still complete the results, graph, conclusion and evaluation.

EVIDENCE

The practicals develop the skills needed for the assignment and for questions on experimental work in the exam; the learn pages and check-ups build knowledge and problem solving. The skills tracker at the back of each workbook can be signed off as you go. Always check the latest course documents and your centre's arrangements.

Contents

Topic 1	Ecosystems	**4**
Topic 2	Distribution of organisms	**7**
Topic 3	Photosynthesis	**9**
Topic 4	Energy in ecosystems	**11**
Topic 5	Food production	**13**
Topic 6	Evolution of species	**15**

TEACHER NOTES

Practical 1: Does crowding slow down growth?

Time	Set up in 20 minutes; measure 7 days later in about 30 minutes. Groups of three, one number of seeds each, then pool results.
Kit per group	Plastic Petri dishes (15 for a full set), cress seeds, cotton wool, 10 cm^3 measuring cylinder, scissors, a balance reading to 0.01 g, labels, a windowsill or light bank.
Prep	Count seeds into labelled envelopes beforehand to save time. Give every dish the same volume of water (about 8 cm^3) and top up on day 3 by the same amount.
Expected results	Crowded dishes give lighter (thinner, often paler) seedlings. Mean fresh mass about 40 mg per seedling at low density falling to about 15 mg at the highest density.
Level	N5 plans the test, names controlled variables, uses repeats and means, draws a line graph and evaluates reliability and validity.

Safety and inclusion

- Use plastic dishes; check for seed or dust allergies; wash hands afterwards.
- Counting and weighing can be shared; a magnifier helps learners with fine-motor or visual needs.
- Risk assess for your own class and follow your employer's policies and SSERC guidance.

Common problems

- **Dishes drying out:** lids on, and water added by measuring cylinder, not by eye.
- **Weighing roots and cotton wool:** cut every shoot at the surface of the cotton wool and weigh only the shoots, straight away before they dry.
- **Calling it interspecific:** one species only, so it is intraspecific.

No lab, no time, or a learner absent?

The sample results let learners complete the means, graph, conclusion and evaluation without growing the cress.

Assessment link

Evidence of planning, controlled variables, recording, means, graphing and evaluating. Good practice for the assignment: compare with a published source on plant spacing and reference it.

Answers: Topic 1

Topic 1: Ecosystems (N5)

1 Living together

1 Population, e.g. all the brown trout in the loch. Habitat, e.g. the reed bed, the stony bottom or the shore.

2 A population: herons are all one species, and a population is all the members of one species in an area.

3 Herbivore: water vole. Carnivore: otter. Predator and prey: otter and trout (or otter and water vole, otter and frog).

4 Biodiversity is the variety (number) of different species, not the number of individuals; the loch has more different species.

2 Food webs

1 For example algae → water snail → trout → otter, or algae → mayfly larva → trout → heron.

2 Algae, pondweed and grass.

3 Trout have fewer snails to eat, so they eat more mayfly larvae, and the number of mayfly larvae falls.

4 She is right in this web: the water vole is the golden eagle's only food shown, so the eagle would have no food (in real life it might eat something else).

3 Niches and competition

1 Any two: the food it eats (fish, frogs, voles); where it nests; that it is a predator; the conditions it needs (shallow water to hunt in).

2 Intraspecific: the trees are all the same species (birch), competing for the same resource (light).

3 Members of the same species have exactly the same needs, so they compete for all the same resources; different species share only some needs.

4 The bluebells get the light before the oak leaves shade them, so they compete less with the oaks for light.

Practical 1: Does crowding slow down growth?

Variables: change the number of seeds per dish; measure the mean fresh mass per seedling (total mass of shoots cut at the cotton wool ÷ number of seedlings) after 7 days; keep the same: volume of water, type and amount of cotton wool, dish size, light, temperature, time, seed type.

Prediction, e.g. the more seeds, the lower the mass of each seedling, because they compete for light, water and minerals.

Equipment: Petri dishes, cress seeds, cotton wool, measuring cylinder, balance (and scissors). Not needed: ruler, thermometer (accept a thermometer to check the temperature stays the same).

Hazards, e.g. glass dishes breaking (use plastic dishes); some learners are allergic to seeds or dust (wash hands, check allergies).

Method key points: same dish, cotton wool and volume of water; same windowsill; cut all the seedlings at the cotton wool, weigh them together, divide by the number of seedlings; three dishes per number; mean.

Sample results (means): 10 seeds: 42 mg; 20 seeds: 38 mg; 40 seeds: 31 mg; 80 seeds: 24 mg; 160 seeds: 15 mg.

Graph: seeds per dish on x, mean fresh mass per seedling (mg) on y; a line that falls, more steeply at first then levelling.

Conclusion: as the number of seeds increased, the mean fresh mass per seedling decreased.

Evaluate: (a) intraspecific (all cress), for light, water and minerals. (b) To make the results more reliable: an odd dish can be spotted and the mean is more trustworthy. (c) Keep all dishes in the same place, with the same light and temperature; pick seedlings at random to measure.

Check-up

1 C (1). 2 B (1).

3 (a) Oak (leaves) (1). (b) Sparrowhawk and blue tit, or blue tit and caterpillar (1).

4 More blue tits survive (1), so they eat more caterpillars and the number of caterpillars falls (1); fewer leaves are eaten, so the oak trees are less damaged (1).

5 They compete for the same food (interspecific competition) (1); greys are more successful, so reds have less food and fewer survive or breed (1).

TEACHER NOTES

Practical 2: Does light intensity affect where daisies grow?

Time	One double lesson outdoors (about 70 minutes) in groups of three, plus 20 minutes indoors for the graph and evaluation.
Kit per group	0.25 m² quadrat, 20 m tape measure, light meter (or phone light-meter app), clipboard and record sheet. Optional: moisture meter for the extension.
Prep	Choose a single tree at the edge of a mown field with daisies. Check the area for hazards, dog fouling and stinging plants. A bright day gives the clearest results.
Expected results	Few or no daisies in deep shade, rising steadily into the open and levelling where light stops being the limiting factor. Mowing height and trampling add scatter.
Level	N5 plans the transect, controls the measuring method, repeats, takes means, graphs and evaluates validity.

Safety and inclusion

- Agree boundaries and a meeting point; check for allergies (pollen, stings) and sun protection.
- Ticks are common in Scottish grass and bracken: long trousers tucked into socks, check skin afterwards and know the signs of Lyme disease.
- Check the forecast; carry waterproofs, warm layers and water; have a wet-weather fallback.
- Keep away from deep or fast water; any stream work only in shallow, slow water with an adult at the water's edge.
- Cover cuts and wash hands before eating.
- Choose level ground so learners with mobility needs can take a full role; recording and light readings can be done standing or seated.
- Risk assess for your own class and site and follow your employer's policies and SSERC guidance.

Common problems

- **Shadows on the meter:** hold it at arm's length, at the same height each time.
- **Counting rule:** agree whether to count plants or flower heads, and how to treat plants on the quadrat edge.
- **Calling light the only factor:** point out trampling, moisture and competition from grass.

No lab, no time, or a learner absent?

The sample results let learners complete the means, graph, conclusion and evaluation indoors.

Assessment link

Evidence of planning, sampling technique, recording, means, graphing and evaluating. Good practice for the assignment: compare with a published field study and reference it.

Answers: Topic 2

Topic 2: Distribution of organisms (N5)

1 What affects distribution?

1 Biotic: rabbits grazing, a fungal disease, a new predator. Abiotic: rainfall, soil pH, wind speed.

2 Any two: hold the meter at the same height; keep her shadow off the sensor; take both readings at the same time of day (or close together in time); in the same weather.

3 For example the probe was not pushed fully into the soil, or the probe was not wiped and had dry soil on it.

4 One reading could be unusual; repeating and taking a mean makes the result more reliable.

2 Sampling

1 For example: quadrats not placed at random (use random coordinates); too few quadrats (use more); counting a plant twice or missing one (agree a rule for plants on the edge).

2 Mean = 20 ÷ 5 = 4 per quadrat = 4 per m^2 (quadrats are 1 m^2); estimate = 4 × 150 = **600 buttercups**.

3 For example: rain flooded the trap (fit a cover/roof); the rim was not level with the soil so beetles walked round it (bury it level); the trap was in the wrong place or set for too short a time.

3 Keys, biodiversity and indicators

1 The water above the drain is clean and well oxygenated (stonefly larvae need this); below it the water is polluted and low in oxygen, because only sludge worms survive.

2 Spider. Model key (others are fine if they work): 1 Leaf made of several separate leaflets: D / Leaf in one piece: go to 2. 2 Edge has deep rounded lobes: C / Edge has no lobes: go to 3. 3 Edge is toothed: B / Edge is smooth: A.

Practical 2: Does light intensity affect where daisies grow?

Variables: change the light intensity (by moving the quadrat along a line from the tree into the open); measure the number of daisies in each quadrat; keep the same: quadrat size, time of day for light readings, the way daisies are counted, the same field.

Prediction, e.g. more daisies where the light is brighter, because they need light for photosynthesis.

Equipment: quadrat, tape measure, light meter, pencil (and record sheet). Not needed: pitfall trap, pH meter, trowel.

Hazards, e.g. tripping over the tape (keep it flat, walk round it); bees or stinging plants (check for allergies, wear long sleeves).

Method key points: run a tape from the trunk into the field; quadrat every 4 m; three quadrats side by side at each distance; light meter at the same height, no shadow, three readings and a mean; count each daisy flower head with a rule for edge plants.

Sample results (mean daisies): 0 m (2 000 lux): 0.3; 4 m (6 000 lux): 4.0; 8 m (15 000 lux): 10.0; 12 m (30 000 lux): 16.0; 16 m (60 000 lux): 17.0.

Graph: light intensity (lux) on x, mean number of daisies on y; a rising curve that levels off.

Conclusion: as the light intensity increased, the number of daisies increased, up to about 30 000 lux, then levels off.

Evaluate: (a) for example soil moisture, competition from grass, trampling or grazing. (b) Light changes during the day and with cloud, so one reading may not show the usual light at that spot; readings at several times give a fairer picture. (c) More quadrats at each distance, or repeat the line in another place.

Check-up

1 C (1).

2 Mean = 15 ÷ 5 = 3 per quadrat (1); per m^2 = 3 ÷ 0.5 = 6 (1); estimate = 6 × 800 = **4800 thistles** (1).

3 A container buried with its rim level with the soil surface, with a cover above it (1); use several traps / check often / repeat (1).

4 With no grazing the vigorous bracken is not eaten (1), so it shades out and outcompetes the other plants, which die, so biodiversity falls (1).

5 Shrubby lichens are indicator species of clean air (1), so the air is cleaner (less polluted) far from the road (1).

TEACHER NOTES

Practical 3: How does light intensity affect photosynthesis?

Time	One 50-minute lesson in pairs: about 5 minutes per distance including settling time.
Kit per group	Boiling tube in a rack or clamp, 8 to 10 cm of Elodea canadensis from a school science supplier (not Cabomba), dilute sodium hydrogencarbonate solution (a pinch per tube), LED desk lamp, metre stick, stopwatch, thermometer.
Prep	Keep the pondweed in bright light for an hour before the lesson. Cut each stem at an angle and put it in upside down so bubbles leave the cut end. Darken the room if possible.
Expected results	Bubble rate falls quickly as the lamp moves away, roughly following the drop in light intensity, then levels at a low rate set by the room light.
Level	N5 plans the test, controls temperature, repeats, takes means, graphs and evaluates accuracy.

Safety and inclusion

- Keep mains lamps and plugs well away from water; use LED lamps, which stay cool.
- Never put pondweed or its water down drains or into ponds or burns; dispose of it in general waste.
- Bubble counting can be paired with a tally clicker; a learner can time and record instead of counting.
- Risk assess for your own class and follow your employer's policies and SSERC guidance.

Common problems

- **No bubbles:** recut the stem and add a little more sodium hydrogencarbonate.
- **Temperature creeping up:** stand the tube in a beaker of water as a heat filter, or use an LED.
- **Measuring distance to the tube edge:** agree to measure from the lamp face to the pondweed.

No lab, no time, or a learner absent?

The sample results let learners complete the means, graph, conclusion and evaluation without the practical.

Assessment link

Evidence of planning, controlled variables, repeats and means, graphing and evaluating. Good practice for the assignment: compare with published growing data and reference it.

Answers: Topic 3

Topic 3: Photosynthesis (N5)

1 Two stages

1 Hydrogen and ATP.

2 In the chloroplasts (mainly of the leaf cells).

3 With no light there are no light reactions, so no ATP or hydrogen is made; carbon fixation needs ATP and hydrogen, so it stops.

4 Carbon fixation is controlled by enzymes, and enzymes work more slowly at low temperatures.

2 Uses of sugar and limiting factors

1 Respiration (to release energy), making cellulose (cell walls), and storage as starch.

2 The leaves made sugar by photosynthesis; it was carried (in the phloem) to the potato and turned into starch for storage.

3 The rate rises as light intensity increases, then levels off (light is no longer the limiting factor).

3 Growing more

1 As the CO_2 concentration increases, the rate increases, then levels off at 23 units per hour from 0.08%.

2 Light intensity or temperature (any factor other than CO_2).

3 Change = 22 − 9 = 13; 13 ÷ 9 = 1.44; × 100 = **144% increase**.

4 Above 0.08% the rate does not increase, because CO_2 is no longer the limiting factor, so extra CO_2 gives no extra growth.

Practical 3: How does light intensity affect photosynthesis?

Variables: change the distance of the lamp from the pondweed; measure the number of bubbles per minute; keep the same: water temperature, the same piece of pondweed, CO_2 in the water (add the same amount of sodium hydrogencarbonate), the lamp, time counted, room light (darken the room).

Prediction, e.g. the closer the lamp, the more bubbles, because light intensity is higher and light is limiting.

Equipment: pondweed in a tube, LED lamp, metre stick, stopwatch, thermometer. Not needed: quadrat, tape measure.

Hazards, e.g. glass tube breaking (handle with care, clamp it); lamp getting hot (do not touch, use an LED).

Method key points: cut stem at the top of the tube; lamp at 10 cm measured to the pondweed; wait 2 minutes; count bubbles for 1 minute; three counts; move the lamp to each distance; check the water temperature each time.

Sample results (means): 10 cm: 40; 20 cm: 23; 30 cm: 14; 40 cm: 9; 50 cm: 6 bubbles per minute.

Graph: lamp distance (cm) on x, mean bubbles per minute on y; a curve falling steeply then levelling.

Conclusion: as the lamp moved further away, the number of bubbles per minute decreased, so the rate of photosynthesis fell as light intensity fell.

Evaluate: (a) an LED gives off very little heat, so the water temperature stays the same and only light changes. (b) Collect the gas in a syringe or measuring tube and measure its volume. (c) To let the pondweed adjust to the new light intensity, so the rate is steady.

Check-up

1 B (1).

2 Hydrogen and ATP from the light reactions are used (1), with carbon dioxide, to make sugar, in enzyme-controlled reactions (1).

3 (14 − 8) ÷ 8 × 100 = **75%** (1).

4 Carbon fixation is controlled by enzymes (1); a higher temperature makes the enzymes work faster, until the optimum (or until another factor limits) (1).

5 Carbon dioxide concentration (accept temperature) (1); add CO_2 (burn paraffin or use bottled CO_2), or heat the greenhouse (1).

TEACHER NOTES

Practical 4: Do living seeds give off energy as heat?

Time	Soak peas the day before. Set up in 25 minutes; read temperatures 48 hours later in 10 minutes; analyse in the next lesson.
Kit per group	16 flasks for a full set; each group does one mass in triplicate and the class pools results. Stainless-steel flasks or insulated plastic containers with lids, digital temperature probes or thermometers, cotton wool, balance, soaked dried peas, a share of boiled peas for the control.
Prep	Soak peas in water for 24 hours. Boil the control peas for 10 minutes and cool them. Rinse all peas in dilute disinfectant to slow mould. Keep the flasks in one place away from radiators.
Expected results	Germinating peas warm by a few degrees over two days; the dead-pea control stays at room temperature. Larger masses give larger rises.
Level	N5 plans the test and its control, repeats, takes means, graphs and links the result to energy loss in food chains.

Safety and inclusion

- Use stainless-steel flasks or insulated plastic containers. Glass-lined vacuum flasks can implode if dropped or knocked: do not use them.
- Use digital probes rather than glass thermometers; stand flasks upright in a rack.
- Dispose of the peas promptly after the final reading; do not open old, mouldy flasks in class.
- Risk assess for your own class and follow your employer's policies and SSERC guidance.

Common problems

- **Tight stoppers:** the peas run short of oxygen and the rise is smaller.
- **Different starting temperatures:** record a start temperature for every flask and calculate the rise.
- **No control:** without dead peas, learners cannot show the heat came from the living seeds.

No lab, no time, or a learner absent?

The sample results let learners complete the means, graph, conclusion and evaluation without the practical.

Assessment link

Evidence of planning with a control, recording, means, graphing and evaluating. Good practice for the assignment: compare with published data and reference it.

Answers: Topic 4

Topic 4: Energy in ecosystems (N5)

1 Energy flow

1 Heat (released in respiration); movement; undigested material (and parts not eaten, such as the hard shell or spines).

2 72 ÷ 900 = 0.08; × 100 = **8%**.

3 Birds and mammals keep a constant warm body temperature, so they release more energy as heat in respiration; less is left to build body tissue.

2 Pyramids

1 One rose bush is a single large producer that feeds many small aphids, so the producer bar is narrow (the size of the organisms is very different).

2 A true pyramid: widest bar at the bottom labelled rose bush, then aphids, then the narrowest bar labelled ladybirds.

3 Energy is lost at every step (heat, movement, undigested material), so each level has less energy than the level below it.

3 Short food chains

1 120 ÷ 1350 = 0.0889; × 100 = **8.9%**.

2 120 ÷ 9 = 13.3, so **13 : 1**.

3 Only 9 kJ reaches the seals compared with 120 kJ in the herring; there is not enough energy to support many seals, because most is lost at each step.

4 Wheat: people eat the producer directly, so the energy lost by the cattle (heat, movement, undigested material) is avoided and more energy reaches people.

Practical 4: Do living seeds give off energy as heat?

Variables: change the mass of germinating peas; measure the temperature rise after 48 hours; keep the same: type and size of flask, starting temperature, room, time, how the peas were soaked.

Prediction, e.g. the more peas, the bigger the rise, because more respiration releases more heat. Control: the same mass of boiled (dead) peas, rinsed in dilute disinfectant to kill microbes.

Equipment: insulated flasks, thermometers, balance, cotton wool, peas. Not needed: light meter, quadrat.

Hazards, e.g. a flask being knocked over (stand it upright in a rack); thermometer breaking (use a digital probe).

Method key points: soak peas for a day; rinse in dilute disinfectant; weigh each mass; fill flask, push thermometer into the peas, plug loosely with cotton wool; record the start temperature; read again after 48 hours; three flasks per mass; control flask of boiled peas.

Sample results (mean rise): 50 g: 0.8 °C; 100 g: 1.7 °C; 150 g: 2.6 °C; 200 g: 3.4 °C; 250 g: 4.1 °C.

Graph: mass of peas (g) on x, mean rise (°C) on y; a straight line rising from close to the origin.

Conclusion: as the mass of germinating peas increased, the rise in temperature increased.

Evaluate: (a) from respiration in the living peas: energy released from glucose is lost as heat, just as it is from organisms in a food chain, so it is not passed on. (b) To show that the rise was caused by the living peas and nothing else; it rose 0.0 °C, so the dead peas gave off no heat. (c) Air can still get in, so the peas get oxygen for aerobic respiration, and the carbon dioxide can escape.

Check-up

1 C (1). 2 B (1).

3 2400 ÷ 30 000 × 100 = **8%** (1).

4 Energy is lost at each level (as heat, movement, undigested material) (1); after a few levels there is not enough energy left to support another level (1).

5 A pyramid of numbers shows the number of organisms at each level (1); a pyramid of energy shows the energy at each level, and is always a pyramid shape (1).

6 People eat the potatoes directly (the producer) (1); feeding the grass to sheep loses most of the energy as heat, movement and undigested material, so less reaches people (1).

TEACHER NOTES

Practical 5: Does fertiliser make duckweed grow faster?

Time	Set up in 30 minutes; count after 14 days in about 20 minutes. Groups of three, pooled into a class set.
Kit per group	Five plastic cups or beakers, 10 cm^3 syringe, 250 cm^3 measuring cylinder, pond or aged tap water, general-purpose liquid plant food, duckweed (Lemna), hand lens, labels.
Prep	Make one stock dilution of the plant food for the class. Choose duckweed plants with two or three fronds each so starting counts are easy. A sunny windowsill or light bank gives results in two weeks.
Expected results	Frond numbers rise with fertiliser concentration and level off at higher concentrations, where something else becomes limiting.
Level	N5 plans the test and control, repeats, takes means, graphs, calculates a percentage change and links the result to algal blooms.

Safety and inclusion

- Eye protection when handling the concentrated plant food; wash hands after handling pond water and plants.
- Cover any cuts with waterproof plasters before handling pond water.
- Counting can be shared and checked by a partner; a printed tally grid helps.
- Risk assess for your own class and follow your employer's policies and SSERC guidance.

Common problems

- **Counting rule:** agree that every separate leaf-like frond counts as one.
- **Water evaporating:** cover the cups loosely, or top up to the mark with plain water.
- **Too strong a stock:** very high concentrations can harm duckweed; stay within the label's range.

No lab, no time, or a learner absent?

The sample results let learners complete the means, graph, conclusion and evaluation without the practical.

Assessment link

Evidence of planning, controlled variables, recording, means, graphing and evaluating. Good practice for the assignment: compare with published nitrate data and reference it.

Answers: Topic 5

Topic 5: Food production (N5)

1 Feeding more people

1 To make amino acids, which are built into proteins needed for growth.

2 As nitrate increases the yield increases, quickly at first, then it levels off at about 6.3 to 6.4 tonnes per hectare above 120 kg per hectare.

3 Change = 5.8 − 3.0 = 2.8; 2.8 ÷ 3.0 = 0.93; × 100 = **93% increase**.

4 The extra 80 kg gives only a small extra yield (0.6 tonnes), so it costs more than it earns, and more nitrate would be leached into the burn.

2 Algal blooms

1 The algae cover the surface and block the light, so plants below cannot photosynthesise.

2 Algae and plants die; bacteria decompose them and their numbers rise; the bacteria use up the oxygen in the water (respiration), so fish die from lack of oxygen.

3 Any two: do not spread fertiliser before heavy rain; add only what the crop needs; leave a strip of grass or hedge beside the burn; use slow-release fertiliser or manure.

3 Pesticides and alternatives

1 6 ÷ 0.002 = **3000 times**.

2 The pesticide is not broken down; it builds up in each organism and is passed on, becoming more concentrated at each level, so the top predator gets a toxic dose from its food.

3 Advantage: no chemicals left in the environment or food chain (or the control keeps working). Disadvantage: the control species may attack other, harmless species or become a pest itself.

4 Less fertiliser would be spread, so fewer nitrates would leach into the burn, and algal blooms would be less likely.

Practical 5: Does fertiliser make duckweed grow faster?

Variables: change the fertiliser concentration; measure the number of fronds after 14 days; keep the same: starting number of fronds, volume of water, type of water, light, temperature, time. Control: 0 cm^3 per litre (pond water only).

Prediction, e.g. more fertiliser, more fronds, because the duckweed gets more nitrates to make proteins and grow.

Equipment: beakers, measuring cylinder, syringe or pipette, hand lens, labels. Not needed: trowel, thermometer (accept a thermometer to check the temperature).

Hazards, e.g. spilt water (wipe up); glass beakers breaking (use plastic cups).

Method key points: dilute a stock fertiliser by syringe into 1 litre of pond water for each concentration; 200 cm^3 in each beaker; 10 healthy fronds per beaker; same windowsill for 14 days; count all fronds with a hand lens; three beakers per concentration; mean.

Sample results (means): 0 cm^3 per litre: 14; 1 cm^3 per litre: 21; 2 cm^3 per litre: 31; 4 cm^3 per litre: 40; 8 cm^3 per litre: 42.

Graph: fertiliser concentration on x, mean number of fronds on y; a rising curve that levels off above 4 cm^3 per litre.

Conclusion: as the fertiliser concentration increased, the number of fronds increased, up to about 4 cm^3 per litre, then it levelled off.

Evaluate: (a) (40 − 14) ÷ 14 × 100 = **186% increase**. (b) Fertiliser makes small water plants grow much faster; leached nitrates would make algae grow fast in the same way, causing a bloom. (c) Keep every beaker in the same light and temperature, start with fronds of the same size, and use the same pond water.

Check-up

1 C (1). 2 B (1).

3 Nitrates cause an algal bloom (1); the algae block light, so plants (and algae) die (1); bacteria decompose them and increase in number (1); the bacteria use up the oxygen, so fish die (1).

4 25 ÷ 0.01 = **2500 times** (1).

5 Less pesticide is needed (so less bioaccumulation), or a higher yield (1).

TEACHER NOTES

Practical 6: Does colour help prey survive?

Time	One 50-minute lesson: 30 minutes outside for three rounds, 20 minutes inside for results and evaluation.
Kit per group	100 paper strips (20 each of five colours, about 1 cm by 4 cm, cut beforehand), a rope or tape to mark a 5 m square, stopwatch, record sheet, sealable bag for the strips.
Prep	Cut and bag the strips. Choose a mown grass area. The scatterer should not be one of the predators. Count all strips back in after each round so none are left as litter.
Expected results	Bright colours (red, yellow, white) are found far more often than green or brown, showing the advantage of camouflage.
Level	N5 plans the model, controls variables, repeats, takes means, draws a bar graph and evaluates the model.

Safety and inclusion

- Walking only; agree boundaries; check for pollen allergies.
- Ticks are common in Scottish grass: long trousers tucked into socks, check skin afterwards and know the signs of Lyme disease.
- Learners with mobility needs can scatter, time or record, or the activity can be done on a large patterned sheet indoors.
- Risk assess for your own class and follow your employer's policies and SSERC guidance.

Common problems

- **Grabbing handfuls:** one strip at a time makes the search fairer.
- **Losing strips:** count them back in after every round.
- **Thinking the model is the real thing:** discuss what it leaves out (reproduction, inheritance, many generations).

No lab, no time, or a learner absent?

The sample results let learners complete the means, bar graph, conclusion and evaluation without going outside.

Assessment link

Evidence of planning, controlled variables, recording, means, graphing and evaluating a model. Good practice for the assignment: compare with a published camouflage study and reference it.

Answers: Topic 6

Topic 6: Evolution of species (N5)

1 Mutation and variation

1 Mutation.

2 Radiation (e.g. UV light, X-rays, gamma rays) and certain chemicals.

3 X-rays are a mutagenic agent that increases the rate of mutation; the badge checks they do not receive a harmful dose.

4 They happen by chance, at any time and in any gene; they cannot be predicted.

5 Longer fur is inherited and helps the mice keep warm in a cold, windy island climate, so they are more likely to survive.

2 Natural selection

1 The resistant rats survived the poison and reproduced, passing on the resistance allele to their offspring; the rats without it died, so over generations the resistance allele became more common.

2 The poison.

3 120 ÷ 4000 = 0.03; × 100 = **3%**.

3 New species

1 B, A, D, C.

2 Ecological.

3 The sea is a geographical (isolation) barrier, so they could not interbreed with mainland mice; different mutations happened on the island; different selection pressures favoured different alleles; over a long time they became very different (perhaps a different species).

Practical 6: Does colour help prey survive?

Variables: change the colour of the strips; measure the number of each colour found; keep the same: number and size of strips, size of the search area, search time, number of predators, how strips are picked up (one at a time).

Prediction, e.g. green and brown strips will be found least, because they are camouflaged against the grass.

Equipment: coloured paper strips, large quadrat or rope square, stopwatch, pencil. Not needed: light meter, thermometer (scissors only to make the strips beforehand).

Hazards, e.g. uneven ground (check the field first); allergies to grass pollen (check before going out).

Method key points: 20 strips of each colour scattered at random by someone who is not searching; predators pick up one strip at a time for 30 seconds; count strips of each colour found; replace strips and repeat for three rounds; mean.

Sample results (mean found): red: 16; yellow: 15; white: 12; brown: 6; green: 3.

Graph: bar graph, colour on x, mean number found on y, gaps between bars.

Conclusion: green strips survived best (fewest found), then brown; red and yellow were found most.

Evaluate: (a) (20 − 3) ÷ 20 × 100 = **85%** survived. (b) The predators (the selection pressure is predation) found the most visible strips, so the camouflaged colours survived; in real life the survivors would breed and pass on their alleles for camouflage colour. (c) The strips do not reproduce, vary or pass on alleles; people are not real predators; there is only one generation.

Check-up

1 B (1). 2 B (1).

3 The antibiotic kills the bacteria without the resistance allele (1); resistant bacteria survive and reproduce (1), passing the allele to their offspring, so it becomes more common over generations (1).

4 The population is split by an isolation barrier so the groups cannot interbreed (1); different mutations occur and different selection pressures act, so natural selection favours different alleles in each group (1); over a long time the groups can no longer interbreed to produce fertile offspring (1).

About the author

C. Blewis has taught for 17 years, including 10 years in Additional Support Needs (ASN) provision, teaching sciences, maths, PE and more.

In many schools, especially smaller and specialist settings, teachers are often asked to teach outside their own subject. These books are written for them, and for the young people they teach: clear, practical and ready to use from the first lesson.