Level

F	1	**2**	**3**	**4**	5	6	B6

*L*ife cycles are not all the same

Strand
Life and Living

Key concept
Evolutionary processes have given rise to a diversity of living things which can be grouped according to their characteristics.

Purpose

Activities in this module are designed to help students understand that there are different kinds of living things, each of which produces young of its own kind. Students have opportunities to:

- investigate the life cycles of selected living things;
- observe the sequence of changes that occur in selected life cycles;
- compare differing needs of living things during different stages of their life cycles;
- communicate their findings in oral form, as illustrations and in tables;
- construct meaning for the term 'metamorphosis';
- make observations about life cycles by identifying similarities and differences between selected life cycles.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory, developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
What do I know?	Life cycle of ants	Comparing and contrasting life cycles
Life cycle of human beings	Life cycle of butterflies	What have I learned?
	Metamorphosis	
	Flowering plants	
	Life cycle of mushrooms	
	Life cycle of fish	

QUEENSLAND SCHOOL CURRICULUM COUNCIL

Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Life and Living

2.2 Students illustrate changes which take place in the course of the life span of living things (including the growth of a plant and an animal).

3.2 Students present information which illustrates stages in different types of life cycles (including metamorphosis) of familiar living things.

4.2 Students identify and analyse similarities and differences in the ways that different living things reproduce.

Core content

This module incorporates the following core content from the syllabus:

Life and Living

Changes in an organism over time

- infant to adult
- egg to adult
- metamorphosis
- aging
- seed to mature plant

Life cycles — plant and animal.

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Life and Living

2.2 Students illustrate changes which take place in the course of the life span of living things (including the growth of a plant and an animal).

Students may:

- explain the life cycles of familiar living things;
- generalise that, when something is living, it is at a particular stage of a life cycle;
- describe the changes that occur to familiar living things as they progress through their life cycles.

Life and Living

3.2 Students present information which illustrates stages in different types of life cycles (including metamorphosis) of familiar living things.

Students may:

- observe similarities and differences between different life cycles and create tables to illustrate these;

- observe examples of metamorphosis and create their own definitions of the term 'metamorphosis';
- identify and discuss the stages of their own life cycle;
- create presentations about life cycles of living things;
- predict later stages in life cycles of living things;
- create definitions of the term 'life cycle'.

Life and Living

4.2 Students identify and analyse similarities and differences in the ways that different living things reproduce.

Students may:

- compare and contrast developmental stages of living things according to the stage of the life cycle;
- compare and contrast reproductive stages of living things and identify changes that occur.

Background information

Current scientific conceptions

Life cycles

The term 'life cycle' describes the development of an organism (living thing) from its inception through to its death. It is the process by which a new organism forms and changes through various stages of its life and ensures the continuation of a species as a whole. The stages of a life cycle are characteristic of each group of organisms and may include, in animals and plants, fertilised egg or seed, juvenile and adult. Also characteristic of each group is how the young are cared for; rituals surrounding reproductive processes; food required at various stages of the life cycle and how the organism takes it in; and its natural life span.

Animal reproduction

Animals have an extraordinary variety of strategies and physical processes to ensure continuation of the species. Some animals, such as tapeworms, have both male and female sex organs and self-fertilise. Others, such as the earthworm, have both sets of sex organs but cross-fertilise.

Most animal species are adapted to sexual reproduction. This allows for a mixing of, and variety in, the genetic material that decides the features of the new offspring. Variation in the genetic material of a species can mean more options for its survival.

The life span of animals varies widely and depends on the species — for example, the life cycle of some moths and butterflies may be only a few weeks, while some tortoises live for more than 100 years.

Metamorphosis

Metamorphosis is a process of change in an animal's form as it develops. This change often means that at a particular stage of its life cycle the animal will look quite different from how it looked in the previous developmental stage. Each stage of a life cycle is characteristic of that organism and is adapted to its special environment and way of living.

Plant reproduction

Plants, which include ferns, mosses, cone bearers and flowering plants, similarly exhibit a range of reproductive adaptations and strategies.

Ferns and mosses

Ferns and mosses usually reproduce by means of spores. Ferns produce spores in structures called sori on the underside of their fronds; mosses produce spores in capsules at the growing point of the plant. Both ferns and mosses have another life cycle stage: the sexual reproduction stage, where genetic mixing occurs.

Cone bearers

Cone-bearing plants include pine trees which have male cones that produce pollen and female cones that produce ovules. Both male and female cones are found on the one plant.

Flowering plants

The reproductive strategies of flowering plants fall into two groups — asexual (vegetative) reproduction and sexual reproduction.

Many plants reproduce by asexual or vegetative means. Strategies employed, and an example plant, include:

- runners — strawberry;
- rhizomes — ginger;
- branches that put down roots where they touch the ground — cape gooseberry;
- suckers — banana;
- bulbs — onion;
- tubers — potato.

People may also propagate plants, such as impatiens and geraniums, from cuttings.

Mechanisms for sexual reproduction vary between plant species. They include self-fertilisation, cross-fertilisation from the same (or another) plant, separate male and female flowers on the one plant (for example, squash) and male and female flowers on separate plants. With flowering plants of a single sex, such as pawpaws, two plants are required to produce fruit, the result of successful fertilisation of the ovule in the female plant.

The life span of flowering plants varies widely. During favourable conditions ephemerals live only long enough to reproduce. This may be only six weeks. On the other hand, some specimens of Australian trees, such as the red cedar and some gums, are known to be hundreds of years old, while other trees, such as the North American sequoia, are believed to be thousands of years old.

Other living things

Fungi obtain their nutrients by breaking down living or once-living material. Fungi grow quickly. This is particularly noticeable at the time of sexual reproduction when there is a mixing of genetic material — fruiting bodies often appear overnight. For example, mushrooms are a fruiting body and each produces thousands of asexual spores on gills. When the spores develop they produce fine thread-like material called mycelium. The fine threads grow over and through any organic material available, absorbing nutrients and hastening the material's decomposition. Mushrooms form as a result of favourable conditions and are the result of sexual reproduction.

Fungi can be parasites of plants (such as smut and rust in wheat, or powdery mildew in squash and peas) and animals (such as ringworm and tinea).

Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways. Some students may think that:

- all things, living or non-living, have a life cycle;
- all living things have the same life cycle;
- human beings are not animals and do not have a life cycle;
- their parents/caregivers are at the end of their life cycle because they seem old;
- a life cycle is linear rather than cyclical;
- 'metamorphosis' is the name of a toy or video game.

Teachers can help students build on their prior understandings by discussing familiar life cycles, such as the human life cycle, with them and by asking students to compare the human life cycle to that of other living things. In this way students will understand that all living things have life cycles but that all life cycles are not the same.

Special considerations

This module suggests activities using specific organisms. Using the suggested organisms may not be suitable across all areas of Queensland or with all students. It is important to use local species where possible, especially those that interest students. It is usually possible to obtain organisms and suitable nutrients from nurseries or biological suppliers (see 'Support materials and references', p. 7). A local ongoing source of the selected organisms' preferred foods needs to be identified to sustain them for the relevant part of the life cycle. A commercial or biological supplier may be able to arrange supply of such foods, but a local, natural source is preferable.

Some activities in this module involve caring for and observing animals over an extended period. These activities will require considerable planning, time and effort. The seasons and the availability of nutrients frequently determine the breeding patterns of living things.

At the conclusion of activities in this module, any native organisms used should be returned to their natural environments. Exotic or pest species should not be released in ways that have an impact on the environment or on native species.

Activities in this module may be integrated into topics presented throughout the year, rather than being completed within a single unit of work. If activities are spread out over time, it may be necessary to devise a culminating activity that allows students to synthesise ideas about life cycles and is appropriate to the current learning context.

Terminology

Terms associated with life cycles are essential to the activities in this module — for example:

adult	egg	moth	reproduction
butterfly	germination	mushroom	seed
caterpillar	hatching	nymph	seedling
chrysalis	juvenile	pollen	sex
cocoon	larva	pollination	social
colony	mating	puberty	spore
cycle	mature	pupa	stage
development	metamorphosis	queen	

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to:

- hygiene when planting and growing plants and mushrooms and when observing living things;
- keeping and caring for organisms in the classroom;
- using potting mix.

Teachers also need to consider policies relating to the ethical care and use of animals in the learning environment.

Support materials and references

Amazing Animals videotape series (for ages 6–12) 1992, Dorling Kindersley, London.

Australian Academy of Science 1994, *Primary Science Investigations: Teacher Resource Book 4 — Patterns and Predictions*, Canberra.

Carle, E. 1969, *The Very Hungry Caterpillar*, Hamish Hamilton, London.

Education Queensland 1997, *The Care and Use of Animals in Schools: Policy and Guidelines*, Brisbane.

Gilbert, A. 1992, *Organic Guide to Bulbs*, Collins/Angus & Robertson, NSW.

Ryan, M. & Brunke, R. 1990, *The Amazing Book of Insects*, Queensland Museum, Brisbane.

See How They Grow: A Dorling Kindersley Book, series, Dorling Kindersley, London:

Burton, J. & Royston, A. 1991, *Chick, Kitten*
Clayton, G. & Royston, A. 1992, *Lamb*
Taylor, K. & Ling, M. 1992, *Butterfly, Owl*
Taylor, K., Burton, J. & Royston, A. 1991, *Frog*
Watts, B. & Royston, A. 1992, *Mouse*

See How They Grow videotape series (for ages 3–6) 1992, Dorling Kindersley, London.

Skamp, K. (ed.) 1998, *Teaching Primary Science Constructively*, Harcourt Brace, Marrickville, NSW.

Organisations

Mt Glorious Biological Centre
Mt Glorious Rd
Mt Glorious Q 4520
Tel: (07) 3289 0161

Mt Glorious Biological Centre supplies livestock including eggs, larvae and pupae of common butterflies. They also offer support for teachers to rear insects, including butterflies. School visits to the site may be arranged.

Queensland Museum Education Resource Service
75 Grey St, Southbank
South Brisbane Q 4101
Tel: (07) 3840 7606
Fax: (07) 3840 7610
Email: loans@qm.qld.gov.au
Website: www.qmuseum.qld.gov.au

ACTIVITY

What do I know?

Introductory

Focus

This activity provides opportunities for students to reflect on what they know about a variety of organisms and to formulate questions to extend their understandings.

Materials

- list of organisms available for investigation
- cards or paper for questions
- a box with a slot in the lid to be a 'postbox'

Teaching considerations

This activity is designed to assist students and teachers to assess what students already know and what more they would like to learn about life cycles.

The 'postbox' technique allows students to ask questions anonymously. Maintain this anonymity even though you may recognise a student's writing and work. Incorporate answers to the questions posted by students in subsequent activities. Alternatively, redistribute the posted questions and allow students to discuss them and formulate answers.

Prepare a list of organisms that thrive in local conditions and represent a range of life cycles. When choosing a final list of organisms to study, ensure that students' selections display a range of life cycles.

Working scientifically

Time: 40 minutes

Reflecting and considering
Clarifying ideas and concepts
Discussing thinking
Supporting decisions

▶ In groups, students brainstorm and create a list of the characteristics of living things. Groups share their ideas and the teacher compiles a class list. Students consider whether any characteristics of living things are not listed. They amend their group list when the class list is final.

▶ In groups, students choose two organisms they would like to investigate.

▶ Students discuss and record what they already know about each organism, something they would like to learn about it, and something they would like to understand better.

▶ Students research their organisms to find out what they wanted to know. They prepare a presentation about their organisms for the class.

▶ Following the presentations, students prepare questions related to any of the organisms discussed. They place these questions in the postbox. Answers to these questions are discussed in class and further research is undertaken if necessary.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions on the characteristics of living things;
- students' lists of characteristics;
- students' presentations.

ACTIVITY

Life cycle of human beings

Introductory

Focus

This activity provides opportunities for students to reflect on and share their ideas about the life cycle of human beings.

Materials

- video, books, posters or other illustrations showing stages of human development
- butcher's paper
- marking pens
- magazines
- scissors
- glue

Teaching considerations

Set up an area where the whole class can sit with the teacher for group discussions.

Create a classroom display of the human life cycle using books, photos and posters.

Working scientifically

Time: 60 minutes

Making and judging observations
Discussing thinking
Illustrating
Retelling and restating

▶ Students view relevant sections of a video showing the human life cycle. Alternatively they could view illustrations from books or posters. They discuss their observations from the video or illustrations with the teacher. The teacher highlights the following points during the discussion:

- Like other living things, human beings have a life cycle.
- The human life cycle is different from the life cycles of other living things such as insects, frogs and plants.
- Humans grow from young to old.
- Life is about growing and changing.
- Humans need to take care of themselves at all stages of their life cycle.

▶ The teacher records the students' observations on a sheet of butcher's paper under the heading 'Life cycles'. Students offer any other thoughts they have about the human life cycle and these are recorded on the butcher's paper, which is then displayed in the classroom for them to refer to.

▶ Following the discussion, students describe phases of the human life cycle. They cut out pictures from magazines to illustrate the cycle from infancy to old age, paste these into their notebooks and label each phase. Students may share their work with each other.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions on the human life cycle;
- students' labelled illustrations of the human life cycle.

ACTIVITY

Life cycle of ants

Developmental

Focus

This activity provides opportunities for students to investigate the life cycle of ants.

Materials

- ant farm or ants collected by students and kept in transparent containers
- *The Amazing Book of Insects* (see 'Support materials and references', p. 7)
- butcher's paper
- marking pens
- Resource Sheet 1, 'Life cycle of ants' (one per group)
- disposable gloves (for all students)

Teaching considerations

Life cycle of ants

Ants are insects and at least 8000 species of ant are known. They are social animals that form colonies and live in nests, sharing the workload of the community. Sometimes hundreds of thousands of ants live in one nest. Individual ants have specific tasks within the colony; some feed and care for the young, others keep the nest clean, fill and maintain food stores or guard the entrances to the nest.

Each colony of ants has at least one queen that lays eggs. The queen or queens also coordinate all of the activities of the colony by chemical communication with workers. Most other ants in a colony are workers. The workers are female, are smaller than the queen and most of them do not reproduce. The workers tend to the queen, care for the eggs and feed and nurture the larvae. They protect the nest and forage outside it looking for food.

Males are found in the colony only when future new queens have been raised. This occurs at certain times of the year or in response to an event such as the nest being damaged or invaded. Each colony produces many winged potential queens and males that fly away from the nest at the same time as those from other colonies in the area. This makes it possible for females to mate with males from other colonies rather than with males from the female's own nest. Unsuccessful males are banished and eventually die. The fertilised queen simply nips or rubs off her wings and begins laying eggs to start a new colony.

Ants undergo complete metamorphosis from larva to adult. The eggs hatch into worm-like larvae that are blind, without legs and totally dependent on the workers who feed and clean them. They are cared for in special chambers within the nest. After they are fully grown, the larvae of most species of ant spin silk cocoons and then pupate. The workers help the new adults out of their cocoons; the new adults then begin looking after the eggs laid by the queen.

Students do not require a comprehensive explanation of metamorphosis at this stage.

Safety

Guide students on the types of ant to collect. Ensure that any ants collected are local species that do not bite. Some students may be allergic to ant bites.

Inform students about safe practices for investigating and handling animals — for example:

- Wear gloves at all times.
- Handle animals in a safe, gentle and non-threatening way.

Working scientifically

Time: 40 minutes

Assessing and reassessing
Clarifying ideas and concepts
Listening and questioning

▶ Students brainstorm what they know about ants. The teacher records their thoughts on the board. Guided by the teacher, students discuss the life cycle of ants. Discussion questions could include:

- Who lays the eggs?
- What does a newly hatched ant look like?
- Why are ants always so busy?
- Do ants die?
- How are ants born?

▶ Students observe ants in an ant farm. If an ant farm is not available, students could capture ants and bring them to school in transparent containers for observation. Ants need air and access to a little water.

▶ The teacher reads to the class the sections on ants from *The Amazing Book of Insects*. Students discuss the life cycle of the ant. In groups they draw a diagram of the life cycle of ants on a sheet of butcher's paper.

▶ Students and the teacher look at Resource Sheet 1, 'Life cycle of ants', that illustrates the various stages of ant development. Students then amend their group diagrams of the life cycle of ants. They cut out and paste the illustrations of the different stages of the ant life cycle from Resource Sheet 1 onto their group life cycle diagram and label the stages correctly. Groups share their completed life cycle diagrams.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions on the life cycle of ants;
- students' amended group diagrams of the life cycle of ants.

ACTIVITY

Life cycle of butterflies

Developmental

Focus

This activity provides opportunities for students to investigate and model the life cycle of butterflies.

Materials

- Resource Sheet 2, 'Life cycle of the wanderer butterfly'
- collection of preserved or dead butterflies; live cocoons and live caterpillars in transparent containers (optional)
- scissors
- glue
- gloves

Teaching considerations

It is very useful to have a collection of preserved or dead butterflies, live pupae and live caterpillars available for students to observe. Students may be able to collect these, or raise live specimens, or the school may borrow a collection from the Queensland Museum (see 'Support materials and references', p. 7, for details).

The silkworm moth is an alternative species that is suitable for study. Its life cycle is completed in about a month.

Life cycle of the wanderer butterfly

The male wanderer butterfly, which looks similar to the female, releases a special chemical to attract the female. He courts her by dancing and showing off his wings of orange, black and white. After mating, the female lays eggs on the milkweed plant. This plant has a very unpleasant smell and is poisonous to other animals. The eggs hatch into larvae called caterpillars that eat the leaves of the milkweed plant. The poison in the leaves enters the caterpillar's body ensuring that the adult butterfly is poisonous to predators.

In a warm climate the caterpillar eats continuously. When fully grown it suspends itself by its tail with a silk pad and girdle and changes into a pupa or chrysalis. The pupa has very thin, shiny skin that darkens as it changes. After about ten days in a warm climate, the butterfly emerges from the pupa. In cool weather it may take several months before the butterfly emerges. The adult lives about six months.

The bright colours of the caterpillar and butterfly act to warn other animals that the wanderer is poisonous. Even a large crow will suffer after eating just one butterfly.

Classroom organisation

Set up an area for class discussions with the teacher.

Refer to the term 'metamorphosis' again in this activity but do not explain it to students at this stage.

If time allows, students draw illustrations or create a model of the life cycle of the wanderer butterfly or other butterfly or moth raised and studied in class.

Safety

Inform students about safe practices for investigating and handling animals — for example:

- Wear gloves at all times.
- Handle animals in a safe, gentle and non-threatening way.

Working scientifically

Time: 30 minutes

Making and judging observations
Reflecting and considering
Constructing and using models


Resource Sheet 2

▶ Students look at Resource Sheet 2, which shows the stages of butterfly development, and then discuss it with the teacher. Discussion questions could include:

- Why are butterflies' wings so strongly coloured? (Refer to butterfly collection if available.)
- What is a pupa?
- Other words used to describe this stage are 'chrysalis' and 'cocoon'. How are these different?
- What changes do butterflies undergo between being a pupa and becoming a butterfly?
- Which stage of the butterfly life cycle hatches from an egg?
- At which stage are the eggs laid?

▶ Students label the developmental stages of the butterfly and then cut out and paste the illustrations and labels in correct order in their notebooks. They write some notes about each stage near the relevant illustration.

▶ Students care for and observe a caterpillar until it turns into a butterfly and then release it.

Additional learning

▶ Students could:

- raise and keep stick insects or grasshoppers to study incomplete metamorphosis;
- investigate the life cycle of other butterflies and compare them with that of the wanderer butterfly;
- investigate why and how the life cycle of a moth is different from the life cycle of a butterfly;
- locate a website that gives up-to-date information about insects and their life cycles.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions on the life cycle of butterflies;
- students' diagrams of the life cycle of the wanderer butterfly;
- students' models or collages of the life cycle of a butterfly or moth (if appropriate).

ACTIVITY

Metamorphosis

Developmental

Focus

This activity provides opportunities for students to explore changes in organisms by comparing features of various life cycles, including metamorphosis.

Materials

- completed life cycle diagrams from previous activities

Teaching considerations

This activity relies on students using information gathered in the previous three activities.

Metamorphosis

Metamorphosis is a process by which an organism changes form completely, either gradually or suddenly, as part of a developmental stage within its life cycle.

Incomplete metamorphosis occurs in some insects. When the young are hatched, they are similar to the adult form but lack wings and mature sexual organs. They complete their development without going through a pupal stage.

Working scientifically

Time: 40 minutes

Looking for patterns and meanings
Making comparisons
Reflecting and considering
Creating tables and graphs

▶ In a discussion led by the teacher, students review the life cycles of the three living things that they have studied previously. During the discussion the teacher introduces the idea of incomplete metamorphosis, such as that in the life cycle of a grasshopper or stick insect. Questions to guide discussion could include:

- Do people change to an entirely different form as they develop?
- What is interesting about the change from larva to adult ant?
- What is interesting about the change from pupa to adult butterfly?
- What is the term that we use to describe this change?
- Do you know of any other living things that undergo metamorphosis?
- What are some insects that change gradually as they grow from juvenile to adult?
- What changes take place as a locust or cicada becomes an adult?
- What is your definition of metamorphosis?

▶ Students construct a table outlining the similarities and differences between the life cycles studied in previous activities. The table may look something like the following:

Life cycle	Similarities	Differences	Metamorphosis
Human being			
Ant or stick insect			
Butterfly			

► In groups, students work together to define the term 'metamorphosis'and present their definitions to the class. Presentations may include role-playing of particular life cycles.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions on metamorphosis;
- students' reflections about similarities and differences between life cycles;
- students' completed life cycle tables;
- students' definitions of metamorphosis.

ACTIVITY

Flowering plants

Developmental

Focus

This activity provides opportunities for students to investigate the growth of flowering plants and to explain the reproductive strategies of these plants.

Materials

- glass jar
- blotting paper
- soil or potting mix
- bean seeds
- black paper
- water
- knife
- plant pots or prepared garden plot
- tomato seedlings
- stakes
- onion or garlic chives bulbs
- potato tubers with sprouting eyes

Teaching considerations

The teacher or students may set up these experiments. As plants can take some weeks to germinate or shoot, prepare them well before undertaking this activity.

To students, plant growth seems very slow, so choose plants that grow quickly and successfully in the local area.

Provide sufficient seeds, bulbs and tubers so that some can be cut open for more detailed observation.

Start extra bulbs and tubers growing some time before students plant their specimens. These older plants can be dissected so that students can observe changes as their plants grow.

Plant growth should be observed over a period of three weeks to three months, or longer if necessary.

This investigation could form the basis of an ongoing activity in which students plant trees and nurture them.

Rhizomes such as ginger could also be used in Part 3 of this activity.

A book like *Organic Guide to Bulbs* may be helpful (see 'Support materials and references', p. 7).

Safety

Inform students about safe practices for handling commercial potting mix — for example:

- Check warnings on the packaging.
- Avoid breathing in dust and spores.
- Wash hands after using the mix.

Working scientifically

Time: Part 1, 30 minutes over two to three weeks; Part 2, 40 minutes over three to four weeks; Part 3, 40 minutes plus observation time

Making and judging observations
Predicting
Constructing meaning
Discussing thinking

Part 1

▶ Students put a cylinder of blotting paper inside a glass jar. They fill the cylinder of paper with soil or potting mix so that the blotting paper is pressed against the glass, and then place bean seeds about half-way down the side of the jar between the glass and the paper. Students cover the jar with black paper, water the seeds and leave them for a few days in a warm place so they can germinate. Students should add water when needed to keep the blotting paper moist, not wet. Students predict what they think will happen to the seeds and record their predictions.

▶ Students observe the growth of the seeds over ten days. They use a table similar to the one below to record their observations of the changes as the seeds germinate.

Day 1	Day 2	Day 3	Day ...	Day X

▶ Students discuss the term 'germination'. They examine seeds at different stages of growth by slicing them in half. From their observations, students make predictions about which parts of the germinating seeds are stem producing and which parts of the seeds are root producing.

▶ Once the seeds have germinated, students transfer them to pots filled with soil or potting mix, or to a garden plot, to observe their growth.

▶ Students draw a diagram of the life cycle of beans. They check the accuracy of their diagram and predictions as they observe the plants growing.

▶ After the plants have matured, students explain what they think has occurred, giving reasons when appropriate.

Part 2

▶ Students plant tomato seedlings in pots filled with soil or potting mix and water them. They place the seedlings in direct sunlight outside the classroom.

▶ Students discuss the terms 'germination' and 'seedling' as they apply to tomato plants and draw diagrams of what they believe to be the life cycle of tomato plants. Students share their diagrams with others in the class.

▶ Students observe and record the growth of the tomato seedlings over three to four weeks by completing a growth chart. They amend their diagrams of the life cycle of tomato plants where necessary as they observe the seedlings' growth.

▶ Students continue to observe and record the growth of the seedlings for a further four weeks, tying the seedlings to stakes when they grow bigger.

▶ Students explain their observations to their peers.

Part 3

▶ Students plant bulbs and tubers so that each one is covered with a layer of soil that is as deep as the object planted is high. For example, a 5 cm onion bulb would be planted 10 cm deep and covered with a 5 cm layer of soil.

The bulbs and tubers are covered with soil or potting mix and then watered. Students may need to refer to the packet in which the bulbs or tubers came for more specific instructions.

▶ Students predict what they think will happen when the bulbs and tubers are planted and record their predictions in words or pictures.

▶ The teacher carefully peels the layers of a bulb that will not be planted, showing the students the starchy storage tissue that contains nutrients for the new emerging plant. After removing the papery outer layer of the bulb, the teacher cuts the swollen stem in two longways from shoot to root for further observation.

▶ Students examine tubers. The teacher explains that new shoots emerge in a spiral pattern, indicating that tubers are underground stems with buds arranged in a pattern in the same way that the emerging plant's leaves will be arranged on the stems.

▶ Over a period of weeks students observe the plants' development and record their observations. They observe the teacher dissect a bulb that has sprouted. They could also partially expose the tubers for observation, re-covering them with soil and watering them afterwards. When a mature specimen of a tuber is available, students compare it with roots and above-ground stems.

▶ Students explain their observations and the meaning they have constructed from these observations.

Additional learning

▶ Students observe zucchini plants as they flower and produce fruit. Students closely examine flowers that are producing fruit and those that are not. They compare the internal appearance of each type of flower by carefully cutting a longitudinal section of them. Students determine which is the female flower (it contains the ovary that will grow to form the zucchini) and which is the male flower (it produces pollen). With teacher guidance, students make a simple line drawing showing the anthers in the male and the growing fruit in the female.

▶ Students explore plant growth from parts of the plant other than the seed. They could use a piece of potato with an eye in it, a carrot top that has been placed in water, a cutting from a coleus or the leaf of an African violet planted in soil, and observe the plant's growth.

Gathering information about student learning

Sources of information could include:

- students' predictions, observations and explanations of a plant's growth;
- students' completed diagrams of the life cycle of beans;
- students' completed diagrams of the life cycle of tomatoes;
- students' completed growth charts for tomato seedlings;
- students' recorded observations of the growth of bulbs and tubers.

ACTIVITY

Life cycle of mushrooms

Developmental

Focus

This activity provides opportunities for students to investigate and illustrate the life cycle of mushrooms.

Students care for and monitor the growth of mushrooms in a mushroom growing kit.

Materials

- mushroom kit
- microscope or hand lens
- knife
- sheets of white paper

Teaching considerations

The timing of this activity is governed by seasonal factors since mushrooms grow best at about 20°C.

Buy a mushroom kit from a reputable garden supplier. Read the instructions on the kit before purchasing it to ensure it is suitable for the time of year you wish to use it.

Organise the activity so that the mushrooms can be observed and harvested at appropriate times during the school program. The kit needs to be kept in a cool place, out of direct sunlight, and should remain undisturbed for the duration of the investigation. The first crop takes about three weeks to mature in favourable conditions.

To make a spore print, cut off the stipe (stem) so that the mushroom cap can sit flat on a piece of white paper. Do not move the cap or paper for at least twelve hours.

Students with vision impairment

Some students with vision impairment may need assistance for this activity. Seek advice from their support teacher.

Safety

Inform students about safe practices for handling commercial mushroom kits — for example:

- Check warnings on the packaging.
- Avoid breathing in dust and spores.
- Wash hands after touching the soil (compost) from the kit.

Working scientifically

Time: Part 1, 30 minutes; Part 2, 20 minutes; Part 3, 20 minutes

Making and judging observations
Making comparisons
Reflecting and considering
Creating presentations

Part 1

► Students create their own concept maps in their notebooks (see the initial in-service materials, p. 38) illustrating what living things need to survive.

► Students read the instructions for growing mushrooms included with the mushroom kit and consider whether information in the instructions corresponds with what they have listed on their concept maps.

▶ As a class, students discuss any differences that arise. Discussion questions may include:

- Do you have something listed as a need that does not appear in the instructions?
- Why do you think this is not listed?
- What information has the kit mentioned that you have not considered?
- What do you think is the source of energy that the mushrooms will use to grow?

▶ Students add their thoughts about these questions to their concept maps.

▶ Students use a hand lens or a reflecting microscope to examine a small amount of soil or mushroom mix from the kit. They may be able to see a mass of fungal threads, collectively called mycelium, and dust-like spores. The teacher models these as simple outline drawings. If appropriate, students copy the drawings into their notebooks to illustrate their own thoughts and observations.

▶ Students prepare the mushroom kit according to the kit's instructions.

Part 2

▶ After the first and second weeks, students observe changes that are visible to the eye and check if any more changes are visible through a lens. Only a very small sample of the mix is needed for viewing under a lens. Students record any changes and their thoughts about these changes in their notebooks. They may illustrate the changes, if appropriate.

Part 3

▶ Students harvest mushrooms at various stages of development — for example, a fully open mushroom with dark brown gills, an immature but open mushroom with pink gills, and one that has not yet opened its cap. Students handle the mushrooms carefully as they observe them and draw what they see. The teacher may model simple line drawings or help students illustrate the mushrooms in other ways. Students could write down some of their observations about a mushroom's texture and smell — for example, 'It smells earthy' or 'It sounds hollow when you tap it gently'.

▶ Students make a spore print of a mature open mushroom. They should observe that the dropped spores make a pattern that looks like fine spokes of a wheel. The teacher explains that the colour of the dropped spores is characteristic of the species.

▶ Students explain the observed life cycle of mushrooms through annotated drawings and notes of their observations.

Gathering information about student learning

Sources of information could include:

- students' concept maps of the needs of living things;
- students' observations and recorded data about mushrooms;
- students' drawings and notes on the life cycle of mushrooms.

ACTIVITY

Life cycle of fish

Developmental

Focus

This activity provides opportunities for students to investigate and illustrate the life cycles of two different types of fish.

Students care for and monitor the growth of fish in aquariums.

Materials

- Resource Sheet 3, 'Life cycle of goldfish'
- *The Very Hungry Caterpillar* (see 'Support materials and references', p. 7)
- aquarium
- gravel, water, water plants and chlorine neutraliser
- goldfish or native rainbow fish (egg layers) or black mollies (live bearers)
- fish food
- small net or scoop for moving fish
- glass or plastic bowl for separating offspring (optional)

Teaching considerations

This activity requires students to observe fish over the months of the breeding season. Complete those aspects of the activity that are suitable for your circumstances.

If you choose to study live specimens, ensure they have a permanent carer when the activity is completed. The same aquarium and fish could be used to study the needs of living things, adaptations and environmental factors.

Under no circumstances release fish into local waterways. They may die or become pests, competing with and killing native fish.

If suitable fish are unavailable for this activity, use snails. However, be aware that they breed so prolifically in an aquarium that they can become pests.

Breeding fish

Successful fish breeding depends on many factors including temperature, food, availability of nesting material and space. It is best to keep fish for most of the year and observe them at critical times. Staff at the local aquarium shop or a hobbyist may be able to advise on the size of the aquarium and the fish most suitable to raise for this activity, including local fish. The Internet is also a source of information.

Some species of fish, such as black mollies or sword tails, are live bearers and others, such as native rainbow fish and goldfish, lay eggs.

Since fish are very sensitive to chemicals in water, it is best to gather fresh rainwater or let reticulated water stand for a day or two before adding it to the tank. If this is not possible, use chlorine neutraliser.

Start with between three and five fish to allow for deaths and to increase the likelihood that you will have females and males. Do not overcrowd the tank as there may not be enough oxygen for the number of fish. Territorial disputes are also more likely in crowded conditions and may result in deaths.

A small motor and aerator available from aquarium or pet shops will maximise oxygen supply. A filter will keep water clear but may be a hazard to young fish.

Goldfish

Goldfish breed in summer. Adult goldfish (more than one year old) can spawn every month during this season. They breed when they are well fed and living in clean water with lots of oxygen. They mate near the edge of ponds and among water plants. The female goldfish lays between 1000 and 3000 eggs over the water plants and the male then fertilises the laid eggs. Goldfish eggs are clear, jelly-like and about the size of a pinhead. They stick to water plants and are often eaten. Young goldfish, called 'fry', hatch and hang from the plants, nourished by their yolk sacs. After a few days they are able to swim away. The fry reach maturity between eight and twelve months of age.

Native rainbow fish

When breeding native rainbow fish, cut short strands of wool and float them on the surface of the water in the fish tank. When the eggs are laid, they settle in the wool and can be moved to a new tank for hatching.

Live-born fish

Live-born fish can be moved into another aquarium so that they are not eaten by adults. Be aware that the offspring may also eat each other.

Safety

Inform students about safe practices for investigating and handling animals — for example:

- Handle animals in a safe, gentle and non-threatening way.
- Minimise disturbance to animals in the aquarium.

Working scientifically

Time: Part 1, 60 minutes; Part 2, 30 minutes for setting up followed by extended periods of observation over the breeding season

Collecting information
Making and judging observations
Making comparisons
Illustrating

Resource Sheet 3

Part 1

▶ Students use Resource Sheet 3, 'Life cycle of goldfish' to identify and discuss different stages of the life cycle of goldfish.

▶ Students write their own narrative stories about the life cycle of goldfish. They could use books such as *The Very Hungry Caterpillar* as models.

▶ Students share their stories with the class. Class members determine whether each student's story covers all stages of the life cycle of goldfish.

Part 2

▶ Students review the information gathered about goldfish and determine what extra information they need to set up an aquarium. They collect this information, discuss how to provide for the needs of the fish and decide which types they might breed successfully.

▶ Students set up the aquarium and let it stand for several days before putting in fish and snails, if appropriate.

▶ Students observe the progress of the fish. They record their observations and draw illustrations of the life cycles they have observed.

Gathering information about student learning

Sources of information include:

- students' stories about goldfish;
- students' discussions of fish and their needs;
- students' written observations and illustrations of the life cycle of fish.

ACTIVITY

Comparing and contrasting life cycles

Culminating

Focus

This activity provides opportunities for students to review, and reflect on, what they have learnt about the similarities and differences between various life cycles.

Materials

- students' life cycle diagrams from previous activities
- video camera (optional)
- butcher's paper
- marking pen

Teaching considerations

As this activity involves group work, it may be best for students to work in an area where extra noise and movement will not inconvenience other classes.

Video recording the role-plays would be valuable when students are analysing their performance in role-plays.

Working scientifically

Time: 60 minutes

Reflecting and considering
Creating presentations
Discussing thinking
Improvising and performing

▶ Students use their life cycle diagrams to review the life cycles they have studied during the module. The teacher assists students to reflect on the term 'metamorphosis' and the stages of the various life cycles investigated.

▶ Working in cooperative groups (see the sourcebook guidelines, p. 60), students choose a life cycle to represent through role-playing. As part of the task, students prepare a definition of the term 'life cycle'. Students have fifteen minutes to create their role-play before presenting it and their definitions of 'life cycle' to the class.

▶ After the presentations, students discuss the role-plays, analysing the stages portrayed and definitions represented.

▶ The teacher writes each group's definition of the term 'life cycle' on a sheet of butcher's paper for classroom display.

Gathering information about student learning

Sources of information could include:

- students' role-plays (or the videos of role-plays);
- definitions of 'life cycle' presented by groups.

ACTIVITY

What have I learned?

Culminating

Focus

This activity provides students with the opportunity to reflect on and restate what they have learned about the life cycles of living things.

Materials

- notes, illustrations and diagrams of life cycles studied

Teaching considerations

This is a reflective activity in which the teacher assists students to focus their attention on the organisms studied and asks students for their thoughts about what they have learned about the life cycles of living things.

Be flexible so that all students may respond openly and to the best of their ability.

Working scientifically

Time: 30 minutes

Assessing and reassessing
Reflecting and considering
Summarising and reporting

▶ Students display their notes, illustrations and diagrams from previous activities so that they may refer to them. They also refer to their earlier reflections in the activity 'What do I know?' (p. 8). The teacher and students discuss the activities they have completed. Discussion questions could include:

- What did you learn about life cycles of living things?
- Do you have any further questions about life cycles that you would like to investigate?
- Are there some aspects of life cycles that you do not understand?

▶ Students write their reflections in their notebooks.

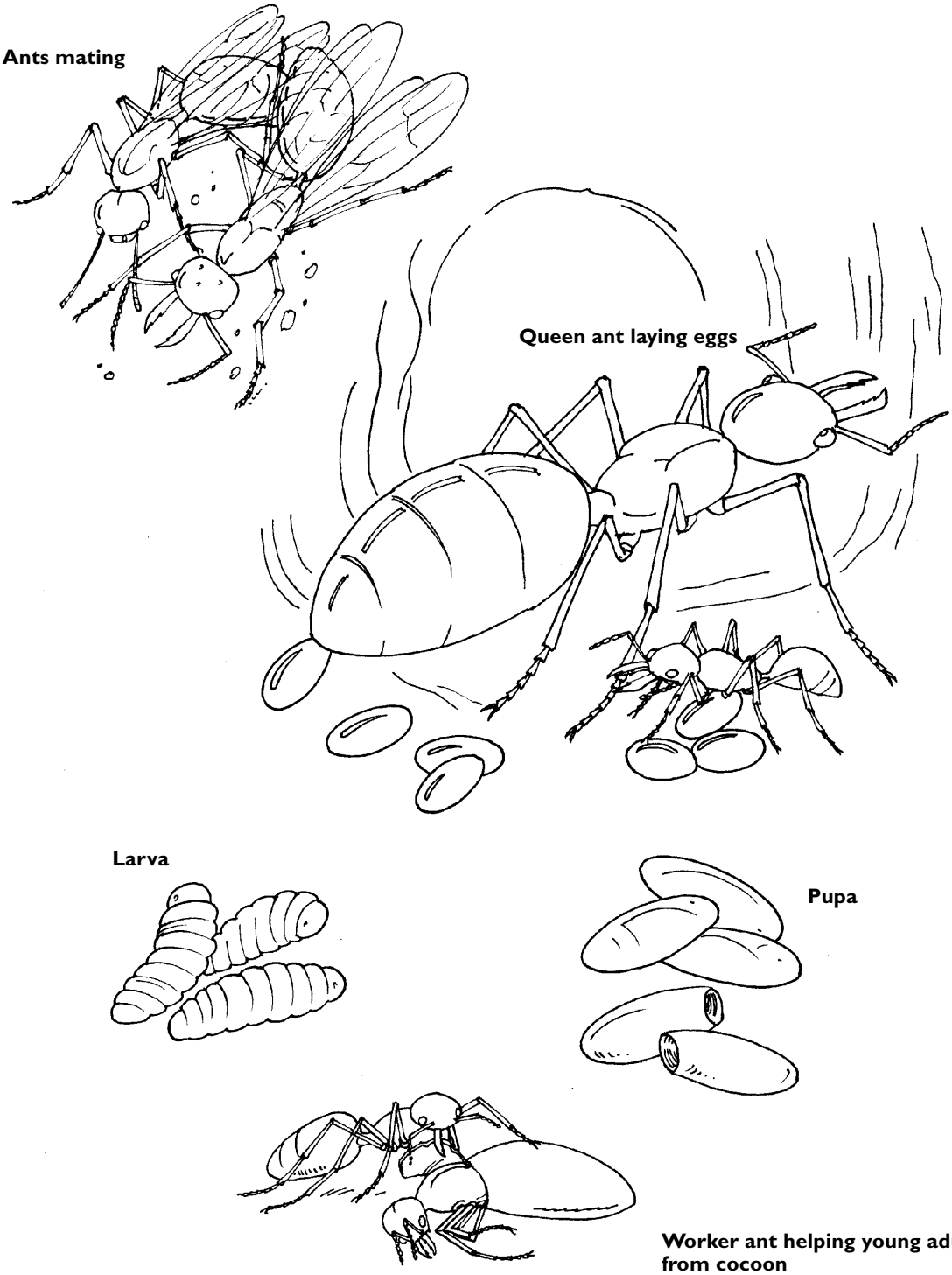
Gathering information about student learning

Sources of information could include:

- students' written reflections.

Life cycle of ants

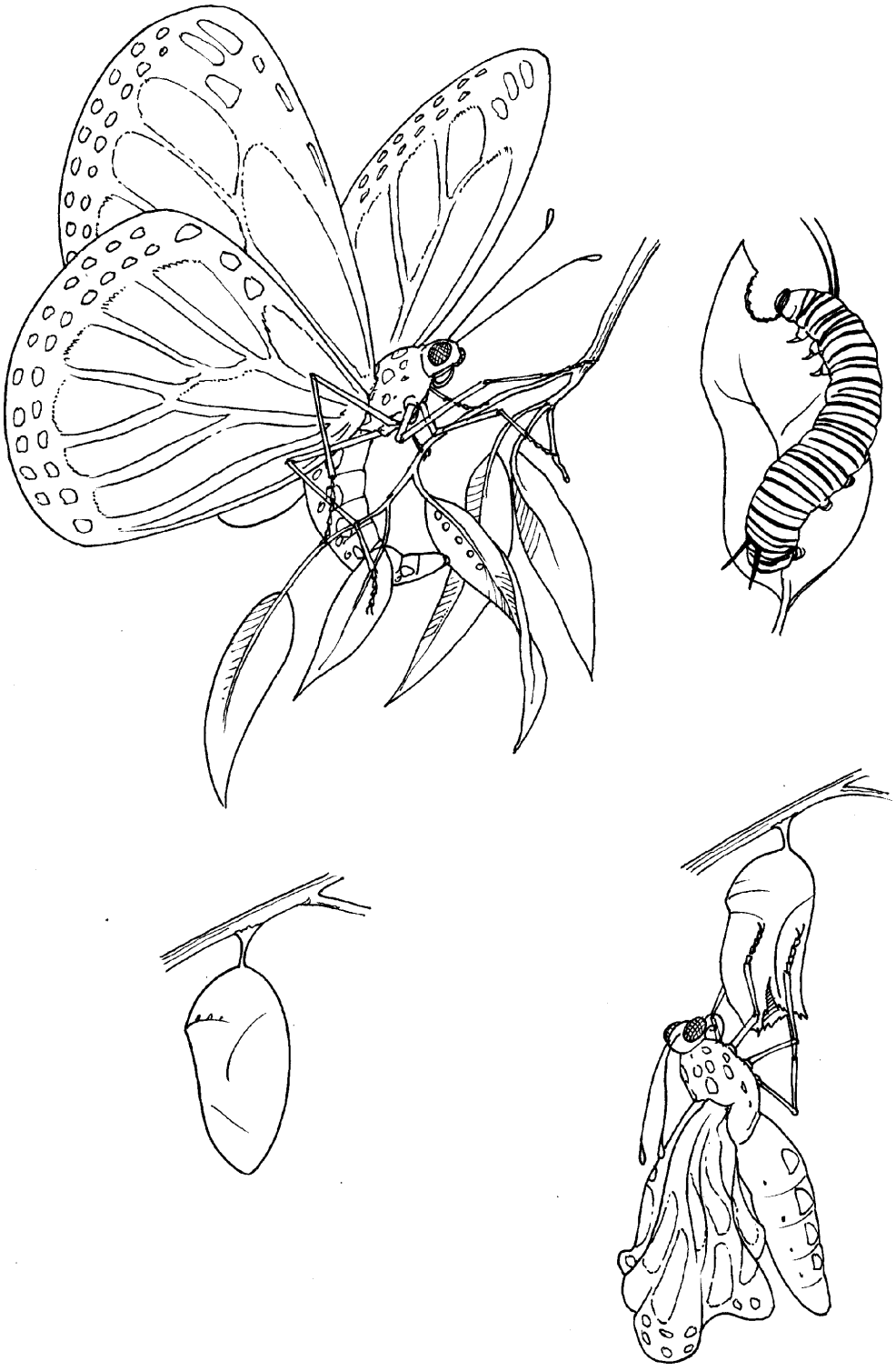
Resource Sheet 1



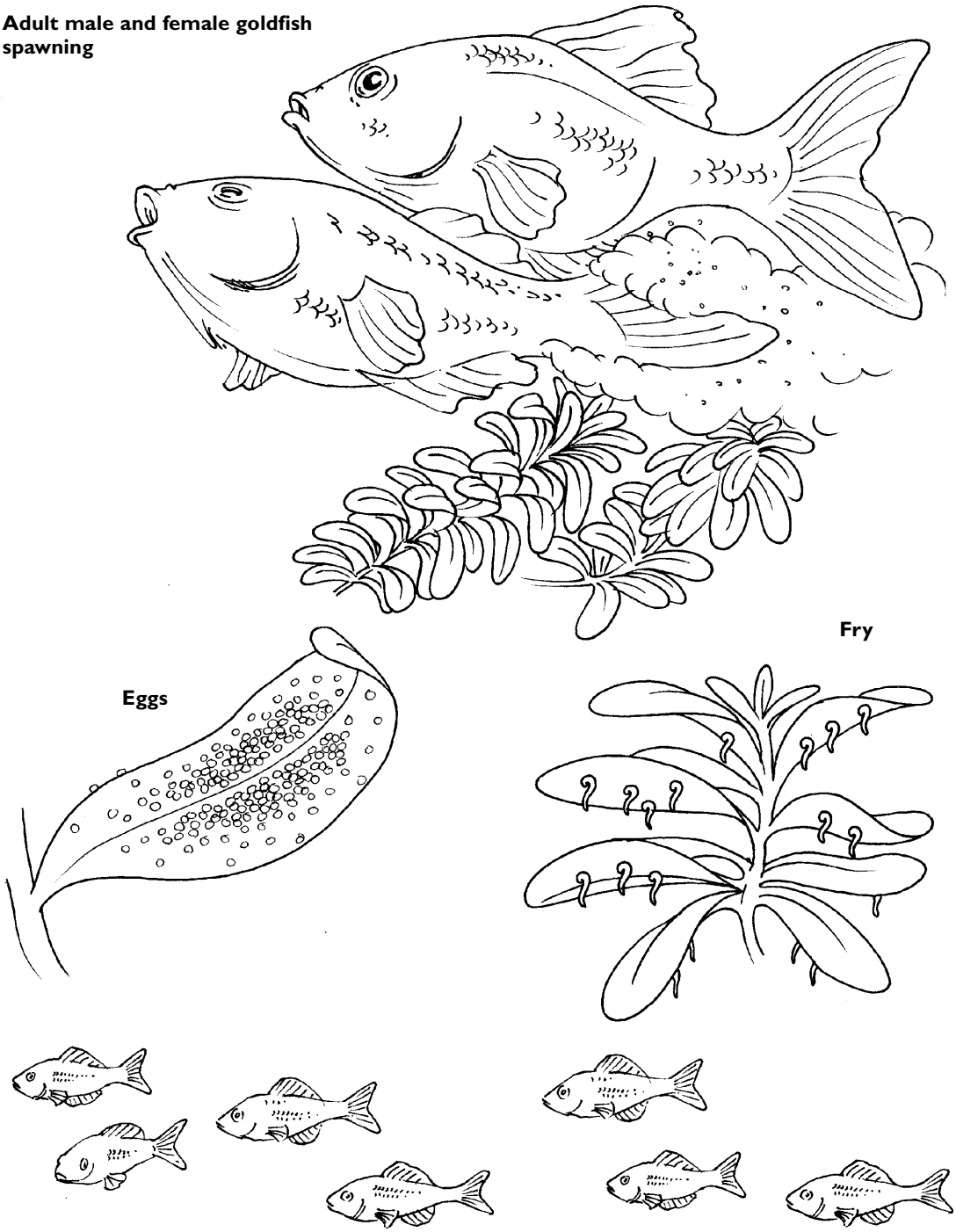
Life cycle of the wanderer butterfly

R2

Resource Sheet 2



Life cycle of goldfish



Acknowledgments

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This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

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Any inquiries should be addressed to:
Queensland School Curriculum Council
PO Box 317
Brisbane Albert Street, Q 4002
Australia

Telephone: (07) 3237 0794
Facsimile: (07) 3237 1285
Website: http://www.qscc.qld.edu.au
Email: inquiries@qscc.qld.edu.au

Illustrations by Stephen Francis

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