5 Systems — reproduction

Sex is fascinating. It has to be! It is the basic foundation for the continuation of life for most organisms on Earth. It can also be dangerous, desperate and competitive, as many insects and spiders would agree. The changes that occur at puberty in humans can be scary and exciting. But they all have the same purpose. They are the means by which you become an adult with the potential of passing on your genetic information to your offspring. It is all a part of the cycle of life. Around and around we go . . .

OVERARCHING IDEAS

- Patterns, order and organisation
- Form and function
- Stability and change
- Systems

SCIENCE UNDERSTANDING

Multicellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce.

Elaborations

Identifying the organs and overall function of a system of a multicellular organism in supporting the life processes

Describing the structure of each organ in a system and relating its function to the overall function of the system

Examining the specialised cells and tissues involved in structure and function of particular organs

Distinguishing between asexual and sexual reproduction

Comparing reproductive systems of organisms

THINK ABOUT REPRODUCTION

- How fast can a sperm swim?
- Why is a dinner date a bad idea for a male red-back spider?
- What do a clitoris and a penis have in common?
- Can sperm build up and burst your testicles?
- If females have about 400 000 eggs at birth, is there a possibility that they can have that many children?
- How big is an 8-week-old fetus?
- Which contraceptives work the best?
- What's a 'test-tube baby'?
- Which foods contain the swollen ovaries of plants?
- Which vertebrates were the first to have a penis?
- Do 'virgin births' really exist?
- What is a hermaphrodite?

Which sperm will fertilise the ovum?

YOUR QUEST

Perhaps you've noticed you're changing

During puberty, your body goes through some interesting, exciting and, sometimes, scary changes.

Investigate

1 In teams, find out the answers to the five questions asked by the students shown below.
2 Share and discuss your findings with those of other teams.

INQUIRY: INVESTIGATION 5.1

What's happening?

KEY INQUIRY SKILLS:

- questioning and predicting
- communicating

DISCUSS AND EXPLAIN

1 In teams of two or more, sketch a figure of a girl and a boy on separate sheets of paper.
2 Add labels to show the changes for each during puberty.
3 Compare and discuss your figures with those of other teams in the class.
4 Make any changes or additions you wish to your diagram.
5 (a) As a team, suggest changes and possible additions to your diagrams.
(b) As a class, collate examples of changes and possible additions to your diagrams.
6 (a) Suggest reasons why these changes occur.
(b) As a class, suggest reasons why these changes may occur.

INQUIRY: INVESTIGATION 5.2

The timeline of our lives

KEY INQUIRY SKILL:

- processing and analysing data and information

DISCUSS AND EXPLAIN

1 Create a timeline to show how you have changed over time: from the ages of 6 months, 2 years, 5 years, 8 years and 11 years to now. You may use photographs, cartoon sketches, or gingerbread or plasticine models.
2 As we are all individuals, our timelines vary. Some of this variation is due to our genes that are inherited; some is due to our environments and lifestyles. Variation is very important for the survival of the species. Compare your timeline with those of others in your class.
3 Record the similarities and differences.
4 Pose questions prompted by your observations and reflections.

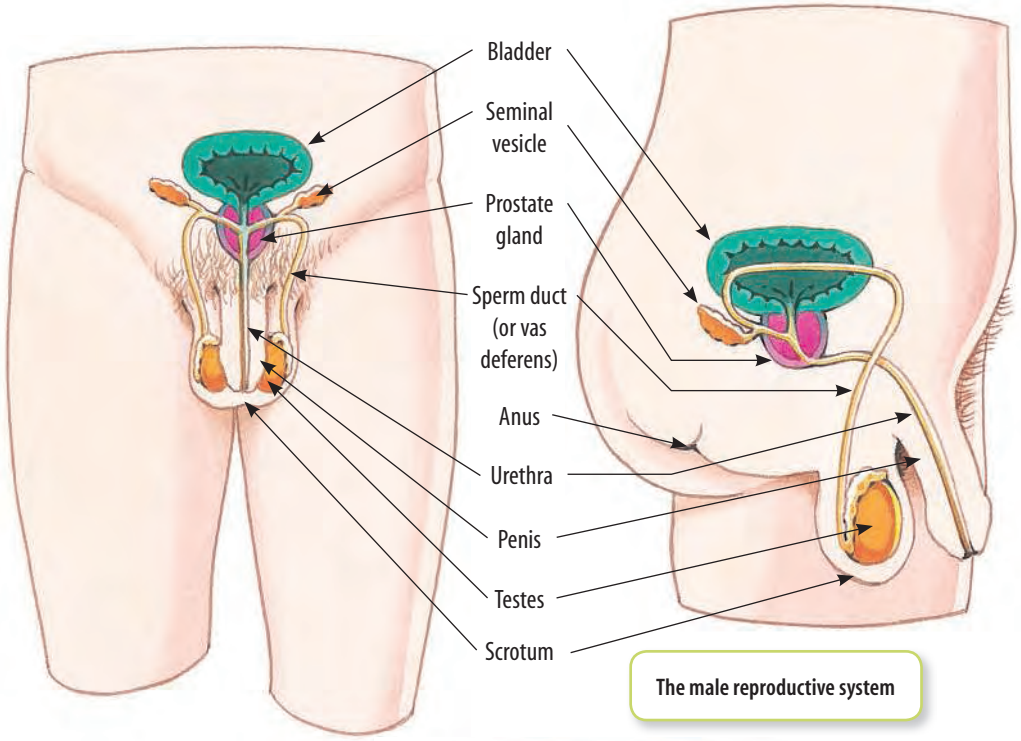
Private parts

We've all got private parts. Let's find out where they are and what they do.

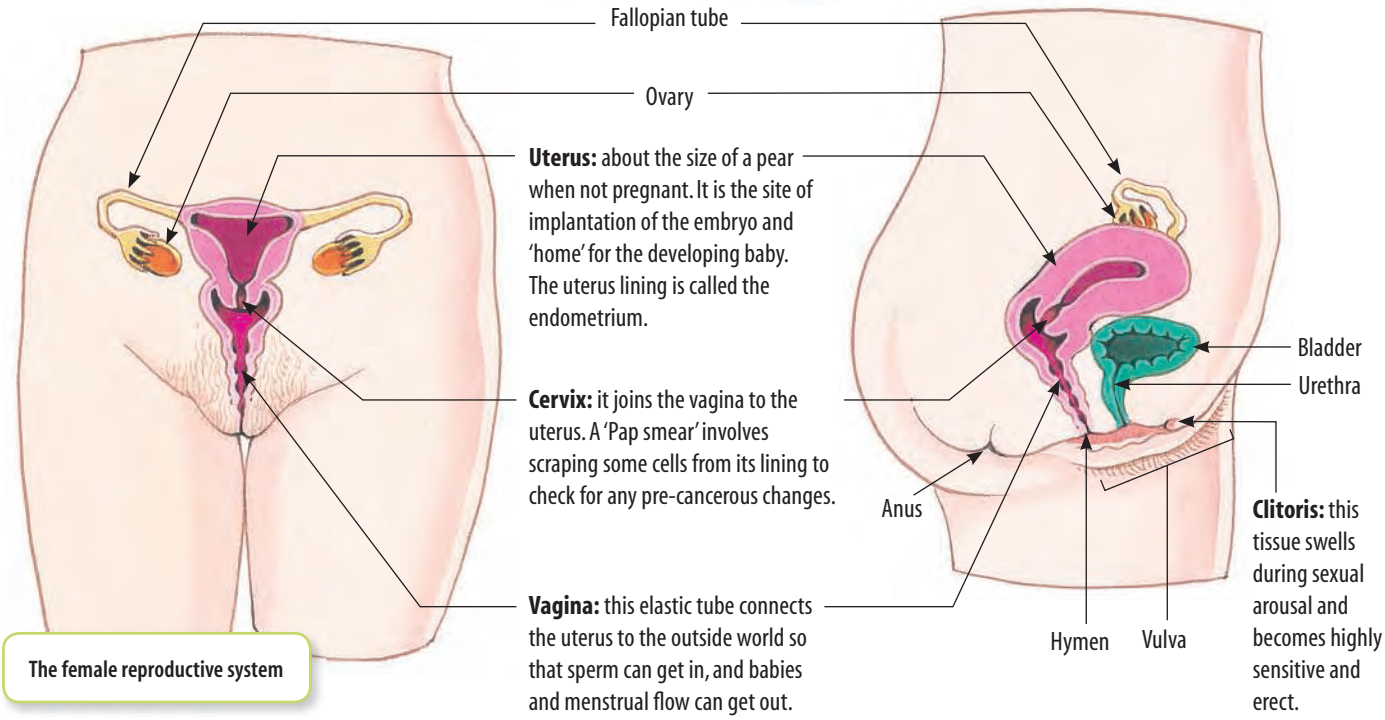
Gamete factories . . .

Although testes and ovaries may look different, these two organs have the same job. They both make gametes.

Sperm are made in the **testes** of a male when he is sexually mature. Testes hang from the body within the **scrotum** to maintain sperm at a temperature of about 3°C below that of the rest of the body. This temperature difference is essential for successful sperm production. Tight underwear or jeans can increase the temperature of the testes and so increase the number of damaged sperm produced.



The male reproductive system



The female reproductive system

Ova (the female's sex cells) are made in the ovaries. Females are born with about 400 000 eggs, or ova, in their ovaries. These eggs are in sacs called **follicles**. Usually only one ovum (singular = ova) is ripened and released into the **fallopian tube** (or oviduct) each month, once the female is sexually mature.

Fallopian tubes are about the diameter of a human hair. They form a tunnel in which the sperm

and ovum meet and are hence the site of **fertilisation**. Damage to these tubes can prevent the sperm and egg from meeting.

If the fertilised egg does not move down into the uterus, but remains in the tube, an ectopic pregnancy may result. If this is not detected and treated within about eight weeks, the tube may rupture and threaten the woman's life.

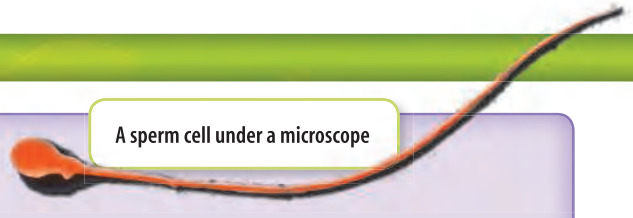
HOW ABOUT THAT!

Did you know that not all plants or animals have separate sexes? Some invertebrates are both male and female at once. These interesting combinations are called hermaphrodites. This enables an individual to achieve greater reproductive efficiency than if it was just the one sex.

Snails have been around for 600 million years and have developed intriguing methods of reproduction. Each snail has an organ called an ovotestis, which makes both sperm and eggs, and a single tube to carry both the sperm and the eggs.

After a complex courtship, in which hermaphrodite snails rear up, each pressing its muscular foot against its partner, and stroking each other with their tentacles, they simultaneously insert their sex organ into the other's body. In this manner, each snail gives sperm to the other and each has its eggs fertilised by the other.

HOW ABOUT THAT!



A sperm cell under a microscope

Amazing sperm

Sperm cells are less than half a millimetre long. Viewed through a microscope lens, spermatozoa (sperm, for short) remind you of tadpoles — a big head and a thin, whippy tail. They form in the testes, but only when the temperature is just right — a few degrees lower than body temperature. This is where the scrotum — a natural thermostat — does its job. It shrivels and scrunches up closer to the body when you are cold (keeping sperm warmer) and hangs away from your body when you are hot (cooling them down).

Parts of the male reproductive system

Part	Function
Testes	Produce sperm cells
Scrotum	Where the testes are located. Keeps the testes at a slightly lower temperature than body temperature.
Vas deferens	The tube through which sperm cells travel from the testes to the penis
Prostate gland	Secretes some of the liquid that is added to sperm cells to form semen. The fluid secreted by the prostate gland is alkaline and contains many chemicals including enzymes. It plays an important role in keeping sperm cells alive once they enter the female reproductive system.
Seminal vesicle	Also contributes some of the liquid that makes up semen. The fluid produced by the seminal vesicle contains proteins, enzymes, sugar, vitamin C and other substances. The sugar provides a source of energy for sperm cells.
Urethra	The tube inside the penis through which semen leaves the male's body
Penis	The penis swells during sexual arousal. Semen containing sperm cells is ejaculated (released) from the penis into the vagina.

Parts of the female reproductive system

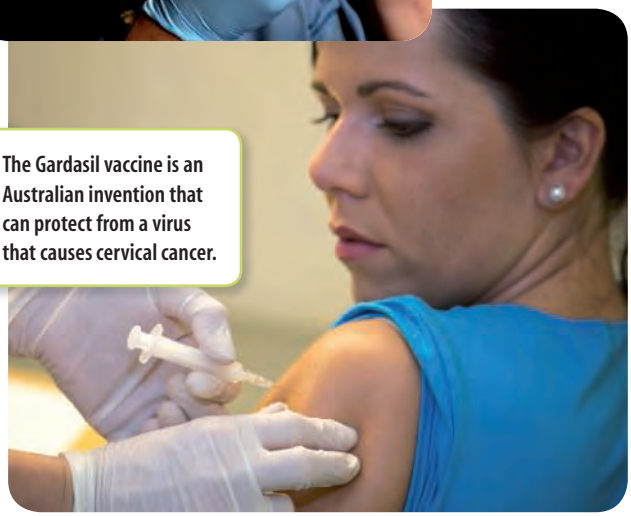
Part	Function
Ovaries	Produce ova. One egg is produced about once a month from one of the ovaries.
Fallopian tubes/ oviducts	Tubes through which ova must travel to reach the uterus. Fertilisation occurs in the fallopian tubes.
Uterus	Where the baby grows and develops
Cervix	The passageway between the vagina and the uterus. During childbirth the cervix needs to dilate (open up) to allow the baby to come out of the uterus.
Vagina	Semen enters the female's reproductive system via the vagina. When babies are born they are pushed out of the uterus and must pass through the vagina to enter the world.
Clitoris	Swells during sexual arousal and becomes highly sensitive when erect

HOW ABOUT THAT!

Sperm by the millions

The average amount of semen produced during an ejaculation (about a teaspoonful) contains about 200–500 million sperm cells! You might think it would take a long time for the testes to make 400 million sperm. Not so. Some 200 million sperm cells are manufactured each day by a fertile adult male. That's around 73 billion sperm cells in a year!

Australian immunologist Professor Ian Frazer developed the cervical cancer vaccine, Gardasil.



The Gardasil vaccine is an Australian invention that can protect from a virus that causes cervical cancer.

Cervical cancer breakthrough

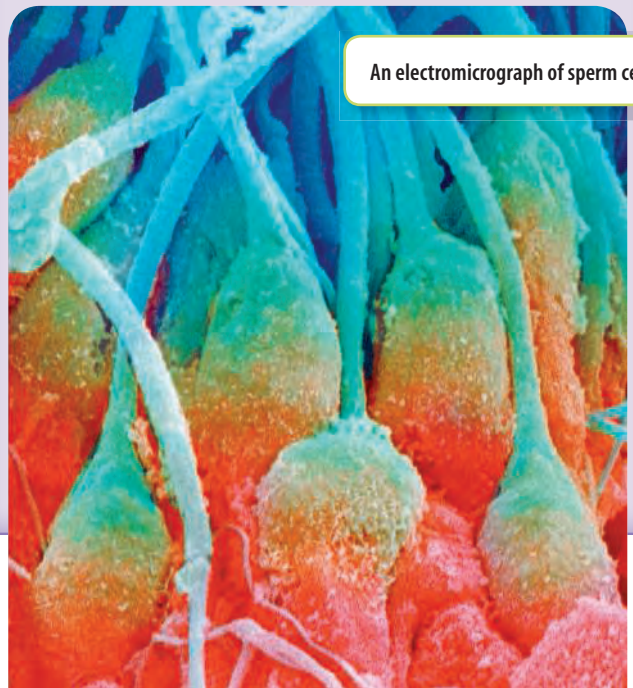
Cervical cancer occurs when the cells of the cervix start to divide abnormally. In its early stages cervical cancer has no symptoms. As the cancer spreads it may cause symptoms such as unusual vaginal bleeding or discharge and lower back or leg pain. When the cancer is discovered in its later stages it is sometimes necessary to remove some of the patient's reproductive organs so that she may no longer have children. The cancer may eventually spread to other parts of the body and cause death. Early detection of cervical cancer greatly increases the chance that a woman will make a full recovery.

A Pap smear is a medical procedure that can detect cervical cancer in its early stages. It involves scraping cells from the cervix and examining them to check for any abnormalities. It is recommended that women have a Pap test every two years.

Cancers can have a variety of causes but most cases of cervical cancer are caused by a virus called human papillomavirus, or HPV. It spreads by sexual contact. While men do not get cervical cancer, they can carry HPV and pass it on to their sexual partners. Professor Ian Frazer, an Australian scientist, recently succeeded in developing a vaccine against HPV. The vaccine, called Gardasil, has the potential to greatly cut down the rate of cervical cancer and save many lives. It is best to be vaccinated when you are young, before you have had a chance to become infected by HPV. For this reason, the Australian government is funding the cervical cancer vaccine for women aged 16 to 26. Different types of HPV can cause cervical cancer and the vaccine protects against about 80 per cent of these, so women who have been vaccinated should still have Pap tests.

HOW ABOUT THAT!

Why do men produce sperm and women produce eggs? Josephine Bowles at the Institute for Molecular Bioscience, University of Queensland, has been researching this question — and she has found an answer. A substance called retinoic acid, a relative of vitamin A, triggers a special type of cell division called meiosis. This results in the production of female gametes or ova. Cells in the testis of the developing male fetus produce a protein that degrades this substance, and so meiosis does not occur and sperm are produced rather than ova.



An electromicrograph of sperm cells

UNDERSTANDING AND INQUIRING

REMEMBER

1 Construct Venn diagrams to compare the following pairs:
   (a) ovaries and testes
   (b) vas deferens and fallopian tubes
   (c) penis and clitoris
   (d) seminal vesicles and prostate gland
   (e) uterus and vagina.

2 Why is tight underwear not recommended for males?

3 What is a 'Pap smear' and why do doctors do it?

4 What is an ectopic pregnancy?

5 Draw a table as shown below. Classify the following organs and list them in the correct column of your table.

fallopian tube, penis, urethra, testes, prostate gland, bladder, uterus, seminal vesicle, ovary, vas deferens, scrotum, cervix, vagina.

Found in males only	Found in females only	Found in both males and females

6 Match each organ with its function. There may be more than one organ with the same function.

Organ	Function
(a) Seminal vesicle	(i) Produces gametes
(b) Ovary	(ii) Where the baby grows and develops
(c) Scrotum	(iii) Where fertilisation occurs
(d) Testes	(iv) Keeps the testes slightly cooler than the rest of the body
(e) Prostate gland	(v) The passageway between the vagina and the uterus
(f) Uterus	(vi) Produces some of the liquid found in semen
(g) Cervix	
(h) Fallopian tubes	

INVESTIGATE, THINK AND DISCUSS

7 Suggest why women with blocked fallopian tubes are unable to have babies.

8 The Australian government currently funds HPV vaccine injections to young women so that it is supplied at no cost to them.
   (a) State what HPV stands for.
   (b) Find out more about the symptoms, diagnosis and consequences of cervical cancer.
   (c) Find out how Gardasil vaccine works.
   (d) Find out more about Professor Ian Frazer's research in Australia.
   (e) Research immunology as a career and then write a diary entry of 'a week in the life of an immunologist'.
   (f) Only young women are obtaining free access to the Gardasil vaccine. Why is this the case? Is this fair? Give reasons for your responses.

INVESTIGATE AND CREATE

9 (a) Construct a model of the reproductive system of:
   (i) a human
   (ii) another animal of your choice.
   (b) Describe how they are similar and how they are different.
   (c) Design and create a third model that has the best features of each.

10 Imagine that you are a sperm or an egg. Find out more about how you are produced, stored and used in sexual reproduction.
   (a) Write a dramatic story about your life.
   (b) Construct puppets, animated cartoons or 'fancy dress' actors to recreate your story as a play.

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11 Test your knowledge of the reproductive organs by completing the **Know your privates** interactivity. **int-0671**

12 Find out more about sperm and ova and represent your findings in the following formats.
   (a) Venn diagram
   (b) PMI chart
   (c) Flowchart

13 Find out more about the structure and function of the human male and female reproductive systems, and design one of the following.
   - A Trivial Pursuit–style game with questions on each system, a board, dice and a rule book
   - An 'information wheel' made of two pieces of circular card connected with a paper fastener ('foldback pin') in the centre. (For an example of how to create an information wheel, see page 182.)

Why the changes?

Perhaps you have noticed that you are changing. Have you noticed any hairs in parts where they weren't before, changes in your body shape or height, changes in your interests . . .?

Changes can be very exciting

Changes that you may currently be aware of are indications that you are becoming an adult. These physical changes are called **puberty**. The term 'puberty' comes from the Latin word *pubertas*, which means adulthood.

The main purpose of the changes that occur in puberty is to enable you to start producing children. Your sex organs grow and develop. Males begin to produce sperm and females begin to develop the ova they were born with. When combined, these gametes can produce babies.

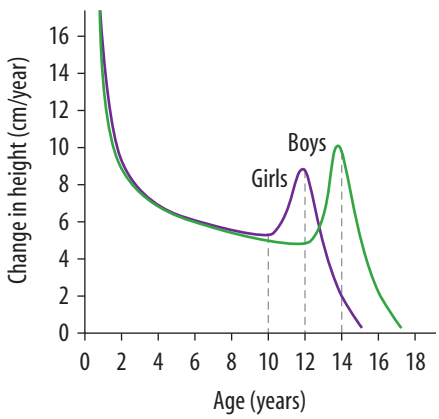
We are all different

It's okay for the changes to occur at different times and at different rates, because everyone is different. We are all individuals. People reach puberty at different ages. Girls reach puberty between the ages of 8 and 17 years and boys between 10 and 18 years. A message from your brain to your sex glands triggers all of these changes. When these glands get the message, they produce substances called **hormones**. These hormones travel around your bloodstream and trigger lots of changes.

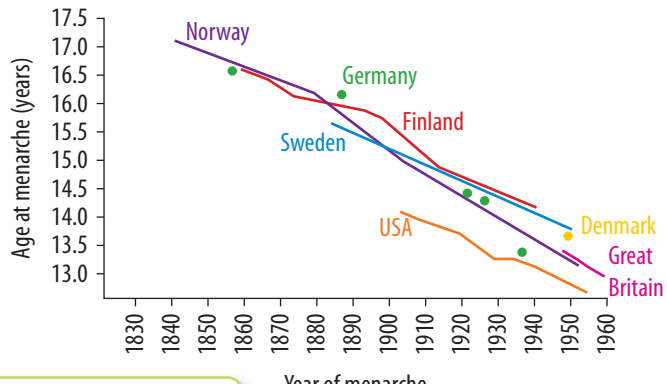
Some common questions

Q: *Why am I getting more pimples?*
A: The sex hormones (testosterone, for example) make the glands in the skin produce extra oils. This can cause the pores in the skin to become blocked and may result in pimples.

Growth rates of girls and boys



Both boys and girls experience a growth spurt around the time of puberty.

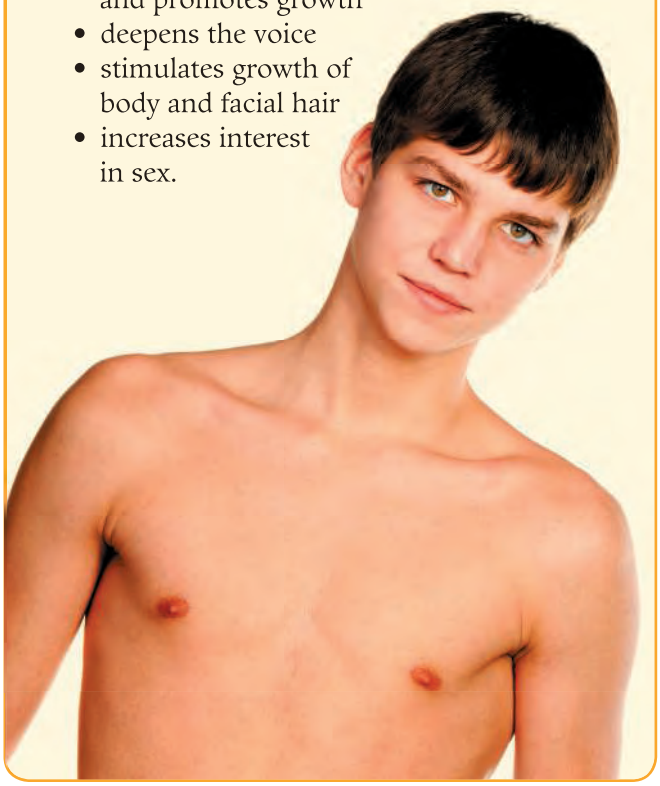


The average age of menarche (the first menstrual period) has decreased over the last two centuries.

Q: *What causes the changes in a boy's voice during puberty?*
A: The voice box, or larynx, gets bigger, making the voice deeper. Males develop a larger larynx so they develop deeper voices. The squeak often heard during this time of change is due to the muscles of the larynx getting momentarily out of control. Although female voices can also change, the final result is not usually so noticeable.

Q: *What role does the male hormone testosterone play in puberty?*
A: Testosterone:

- is needed for sperm production
- not only enlarges the penis, testes and scrotum, but also increases their sensitivity
- increases body muscle bulk and promotes growth
- deepens the voice
- stimulates growth of body and facial hair
- increases interest in sex.



Q: *In which new places am I likely to grow hair during puberty?*
A: If you are female, it's likely to be around your pubic region and under your arms. Males may notice an increase in these regions and also on their legs, arms, faces and chests.

Q: *What is masturbation?*
A: Masturbation involves touching or rubbing your genitals to give sexual pleasure. It can result in an orgasm — a throbbing feeling that brings intense pleasure. Masturbation is a harmless and natural way of exploring your sexuality on your own. Australian surveys show that by their late teens most males and females have masturbated. Some people don't feel the need to masturbate at all, and that's normal too.

Q: *What's the average penis size?*
A: The length of a fully grown penis usually ranges between 8 and 10 cm when soft, and between 12 and 18 cm when erect. As you can see, penis sizes vary greatly (vaginas vary in size too). The size of the penis has nothing to do with a person's masculinity or sexual performance.

Q: *I seem to have erections all the time! Why?*
A: Waking up with an erection can be caused by a full bladder or the effects of a dream. Raised levels of testosterone can also cause erections.

Q: *What are wet dreams?*
A: These dreams happen to a boy during sleep and result in ejaculation of semen. They are quite normal (although not all boys have them) and are an indication that you are becoming sexually mature.

Q: *Can sperm build up and burst your testes?*
A: No, unused sperm are stored for a while and then reabsorbed into your body. New sperm replace them.

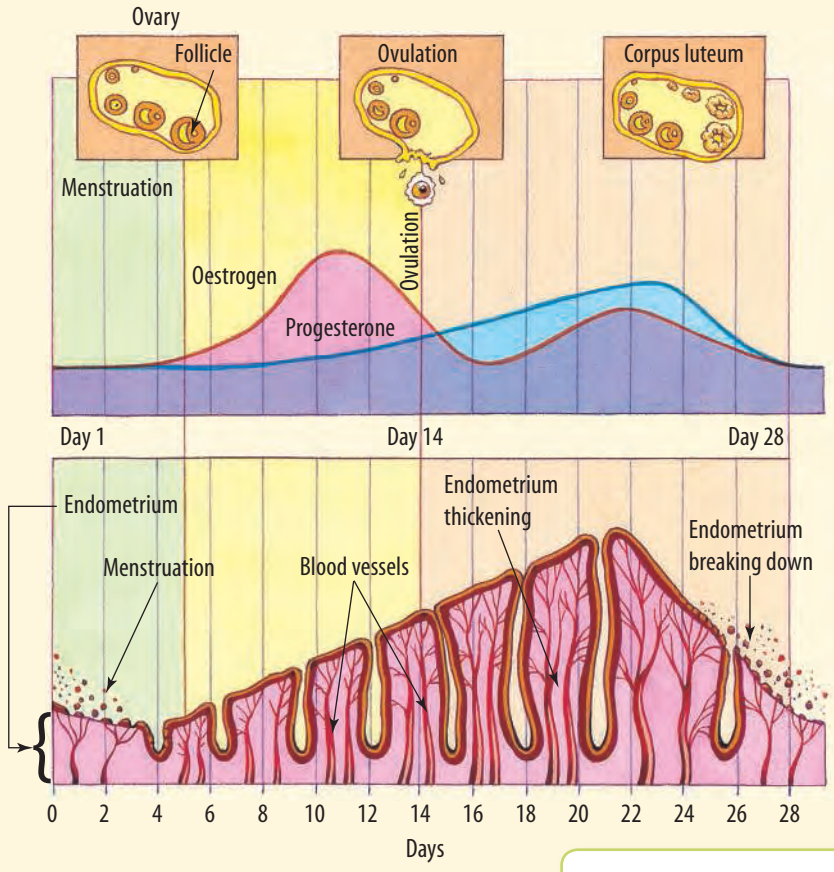
Q: *What is a breast bud?*
A: This is a little button of tissue just under the nipple from which the breast develops. Sometimes boys also get breast buds, but in their case they go away and do not develop.

Q: *At what age do you get periods and how long do they last?*

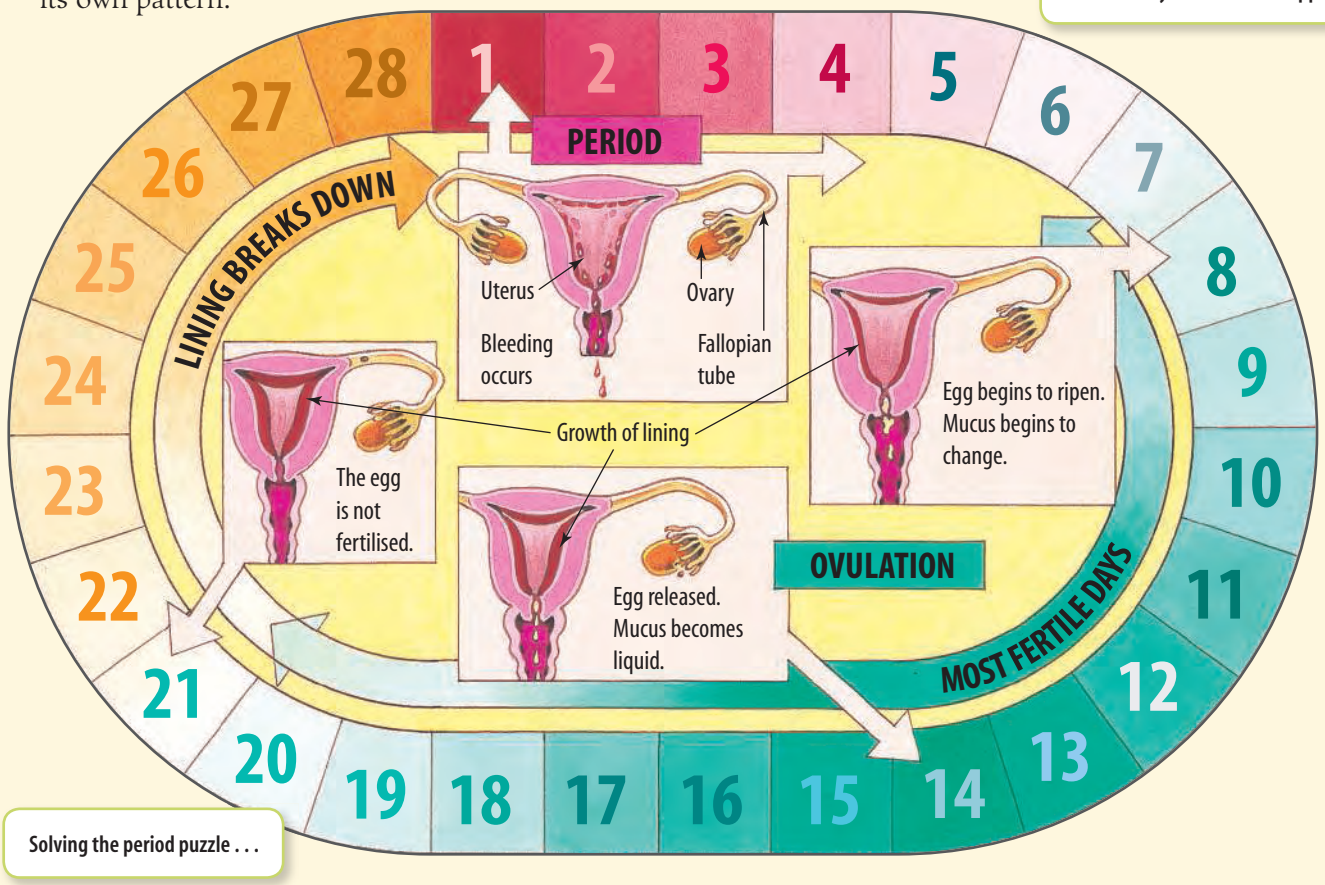
A: Most girls experience their first period between the ages of 11 and 14, although others may have it up to two years earlier or later. The first menstrual period is called **menarche**.

A period generally lasts about four to six days, with varying amounts of discharge over this time. The discharge contains cells from the lining of your uterus that was built up in preparation for a baby.

Your **menstrual cycle** is the time from the first day of one period to the first day of the next. It is usually about 28 days, but this varies in different women. It is quite common for your menstrual cycle to be irregular at first — until your body settles into its own pattern.



Menstrual cycle — what's happening?



Solving the period puzzle . . .

Q: *What is ovulation?*
A: Although all the eggs or ova are present at birth, it is only during puberty that they begin to ripen. Each month, one ovum matures and is released from the ovary into the fallopian tube. The release of the ovum is called ovulation. This continues about every 28 days until the woman enters menopause.

Q: *How many eggs are girls born with and about how many develop?*
A: Girls are born with about 400 000 eggs. Only about 400 of these will mature and be released during her menstrual cycles; the others will not mature.

Q: *What are periods?*
A: Each month, the lining of the uterus prepares itself for the fertilised egg. If the egg is not fertilised, the uterus lining is shed through the vagina. This monthly discharge, or shedding, is called **menstruation**, or a period. Sometimes there may be some discomfort or abdominal cramps during the first few days of your period. If you are having periods, it is a sign that you are also ovulating. This means that you are physically able to get pregnant and have a baby.

Q: *Is it true that you can't wash your hair, eat ice-cream or play sport during your periods?*
A: No. Having periods shouldn't affect your normal activities.

Q: *What is the difference between menstrual pads and tampons?*
A: Pads, or sanitary towels, are made of soft cotton materials with one waterproof side. They are worn outside the body and press on to fit inside your knickers. Tampons, however, are a tight roll of cotton wool with a string at one end. These are inserted into the vagina. Both of these sanitary products soak up menstrual blood.

Q: *FSH, LH, oestrogen and progesterone: what are they?*
A: FSH (follicle-stimulating hormone), LH (luteinising hormone), oestrogen and progesterone are all hormones. FSH and LH are hormones that make ova develop in girls' ovaries and begin sperm production in boys' testes. Oestrogen and progesterone are produced in the ovaries. They are the most important female hormones and are involved in changes in the lining of the uterus. The hormones control the menstrual cycle as shown in the diagram on the previous page.

HOW ABOUT THAT!

The feeling of 'being in love' is not a product of the heart. That happy, dreamy feeling experienced when you 'fall in love' is partly due to a chemical produced in your brain, called phenylethylamine. As chocolate also contains phenylethylamine, it is no wonder many people describe themselves as 'chocolate lovers'.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Use a table to give definitions of the following terms: puberty, menstruation, ovulation, masturbation, menarche, menstrual cycle, hormones, testosterone, wet dreams, breast buds.

2 Which hormones are responsible for triggering sperm production in males and ovum development in females?

THINK AND REASON

3 Use the illustration of menstruation and other information in this section to answer the following questions.
   (a) What is ovulation?
   (b) At what day in a 28-day cycle is ovulation likely to occur?
   (c) At which time in the cycle is sperm most likely to meet (and fertilise) an egg?

4 Describe the changes in oestrogen and progesterone levels throughout the menstrual cycle.
   (a) Which hormone is found in the highest concentration just before ovulation?
   (b) Which hormone is found in the highest concentration when the uterine lining is thickest?
   (c) At which time would the lining provide the best 'home' for a fertilised egg?

5 Translate the graph on page 180 into a 28-day calendar.

THINK AND DISCUSS

6 Suggest why the hips become 'fleshier' and the pelvic bones widen in females during puberty.

7 The testes continue making sperm for the rest of a man's life. How is this different from gamete production in a woman? What are the consequences of this?

8 If a female has menstrual cycles, is she potentially able to have babies? Explain.

9 Why aren't all menstrual cycles, penises and breasts the same?

INVESTIGATE

10 Write down ten questions that you have about puberty or reproduction. Use a variety of texts and resources to find the answers to them. Report the findings to your friends.

CREATE

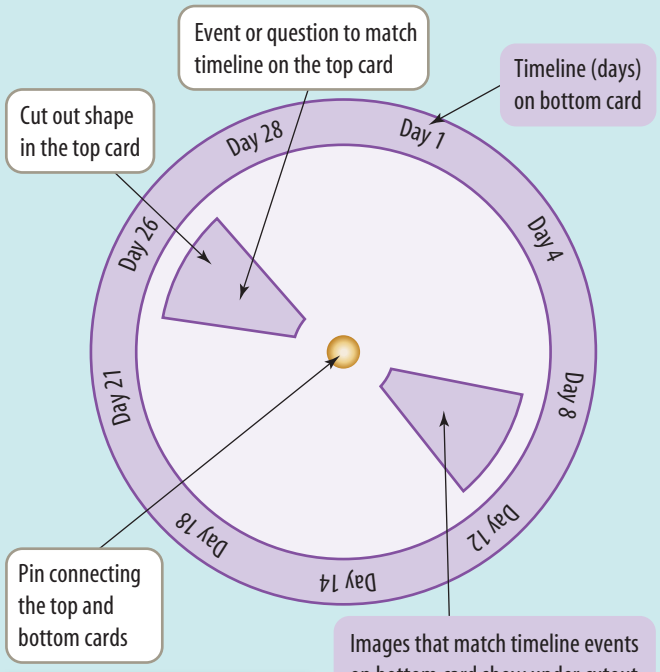
11 Construct a crossword with your own clues and answers, from information found in this section.

12 Write and act out a play to demonstrate the menstrual cycle. Include the following stages: egg ripening, ovulation, movement of the unfertilised egg into the fallopian tube and through the uterus, and both the egg and the uterine lining being shed through the vagina.

13 Get everyone in the class to write down two to five questions about the changes that occur during puberty and reproduction in a 'Dear Ethel' magazine format. After your teacher has collated these, select at least two to investigate. Report your findings by compiling a class 'Dear Ethel' magazine.

14 Copy and complete the table below. Use this table to help you construct an 'information wheel' about the human menstrual cycle.

Day in cycle	Key events	Hormonal changes	Possible images to include
1			
4			
8			
12			
14			
18			
21			
25			
28			



This is an example of how you might design your information wheel on the menstrual cycle, but there are many others. In this example, the bottom circle of the card is larger than the top piece. You may decide to reverse this or have both pieces the same size and add holes in the top piece to see the days of the timeline.

work sheets
- 5.1 Puberty and boys
- 5.2 Puberty and girls
- 5.3 Menstruation

5.3 SCIENCE UNDERSTANDING

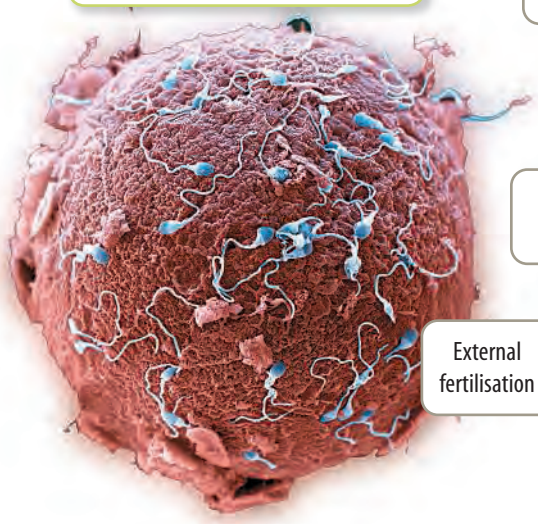
Getting together

Let's talk about sex. Sexual reproduction is not something to be embarrassed about, but something incredible and fascinating.

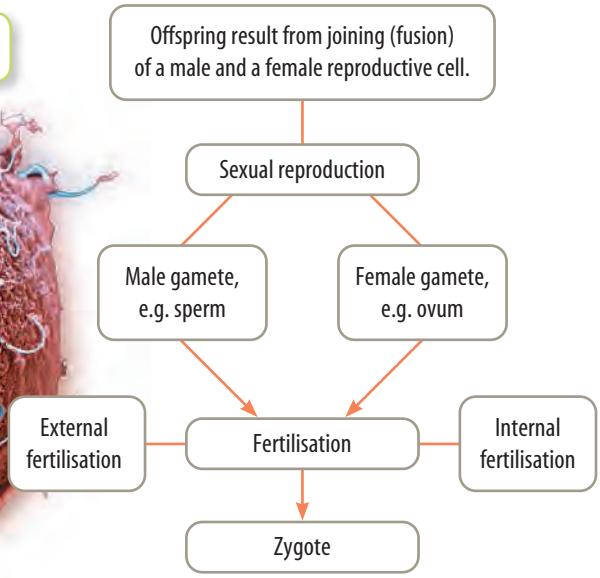
Snap!

Sexual reproduction occurs when offspring result from the joining (fusion) of a male reproductive cell and a female reproductive cell. These special reproductive cells are called **gametes** and are made in the reproductive organs of organisms. In animals, male gametes are called **sperm** and female gametes are called **ova** (singular = **ovum**) or egg cells.

Reproductive systems are designed to bring the male and female gametes together. The joining of sperm and egg cells is called fertilisation. This process mixes the genetic material from the nucleus of each parent together and results in the formation of a **zygote**.



Human sperm cells surround an ovum.

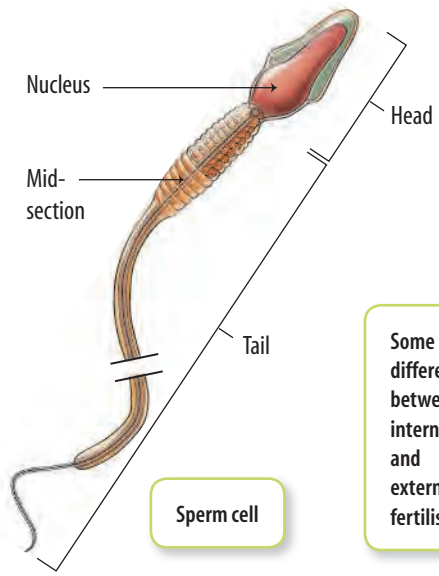


MEETING OUTSIDE . . .

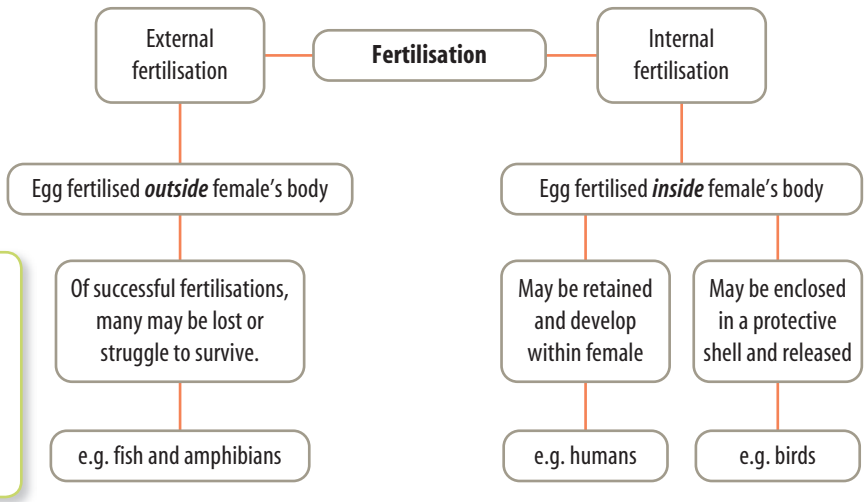
In some animals, especially those that live or breed in water such as fish and amphibians, fertilisation occurs *outside* the female's body. This is called **external fertilisation**. In this situation, the female releases her unfertilised eggs into the water to be fertilised by the male's sperm, which are also released into the water.

MEETING INSIDE . . .

In animals that live and breed on land, **internal fertilisation** occurs. This keeps the gametes inside the body so there is no chance of dehydration occurring. In this situation, sperm are introduced into the female by a process called **copulation** (or **sexual intercourse**).



Sexual reproduction involves fusion of gametes.



Some differences between internal and external fertilisation

Ova

Like sperm, ova are produced by a special type of cell division called **meiosis**. Unlike sperm, however, the ova that will be released throughout the female's reproductive years are already present at her birth. This brings differences in terms of **epigenetics** — an exciting new branch of science that involves studying the effect of our experiences on the expression of our genetic information.

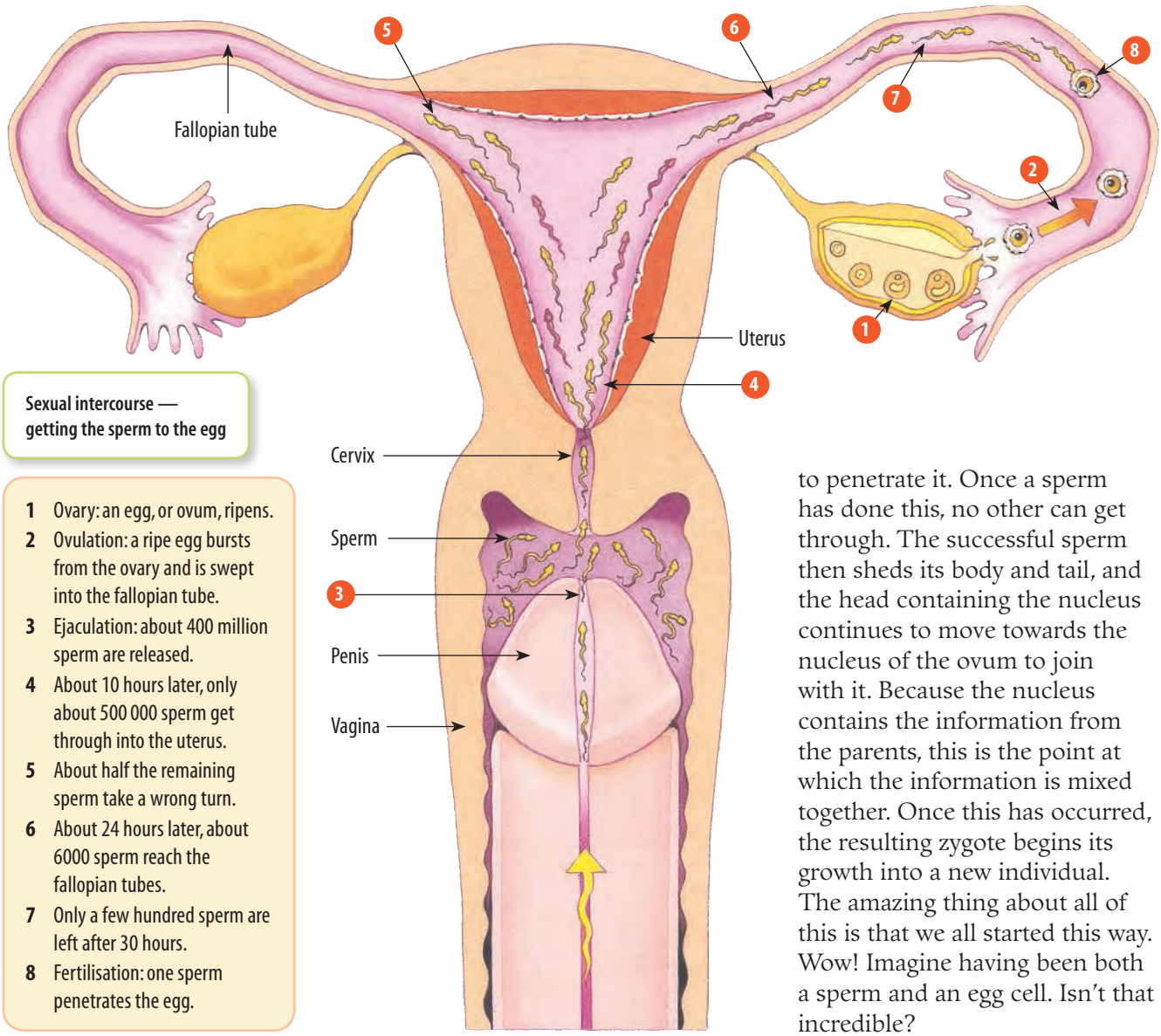
Although the resulting zygote will contain a mixture of the genetic material (**nuclear DNA**) from the nucleus of both the sperm and the ovum, it will contain the genetic material from mitochondria (**mitochondrial DNA** or **mtDNA**) only from the mother's ovum. MtDNA forms the basis of many new genetic and evolutionary studies.

Sperm

In humans, the sperm are mixed with a nutrient-rich fluid before their release, or **ejaculation**, from the male's penis. This combination of fluid and sperm is referred to as **semen**. The sperm make up less than one per cent of the semen. An ejaculation may release about 400 million sperm. Sperm are made up of three distinctive parts: the head, the middle section and the tail. Swishing its tail, and powered by the middle section, the sperm swims like a tadpole at about 4 mm per hour to reach its goal — the egg.

SUCCESS, AT LAST!

Upon reaching a ripe egg, hundreds of sperm surround it and try to break through. The sperm release an enzyme that dissolves the covering of the egg and enables one of them to penetrate it. Once a sperm has done this, no other can get through. The successful sperm then sheds its body and tail, and the head containing the nucleus continues to move towards the nucleus of the ovum to join with it. Because the nucleus contains the information from the parents, this is the point at which the information is mixed together. Once this has occurred, the resulting zygote begins its growth into a new individual. The amazing thing about all of this is that we all started this way. Wow! Imagine having been both a sperm and an egg cell. Isn't that incredible?

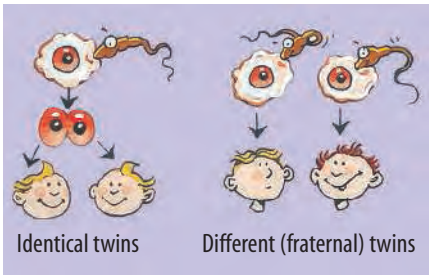


Sexual intercourse — getting the sperm to the egg

1. Ovary: an egg, or ovum, ripens.
2. Ovulation: a ripe egg bursts from the ovary and is swept into the fallopian tube.
3. Ejaculation: about 400 million sperm are released.
4. About 10 hours later, only about 500 000 sperm get through into the uterus.
5. About half the remaining sperm take a wrong turn.
6. About 24 hours later, about 6000 sperm reach the fallopian tubes.
7. Only a few hundred sperm are left after 30 hours.
8. Fertilisation: one sperm penetrates the egg.

Two or more?

Sometimes in the very early stages of division following fertilisation the embryo splits in two, so that two identical offspring are produced. This happens in the case of **identical twins**. They will always be the same gender as each has the same genetic make-up as the other.


Identical twins Different (fraternal) twins

Usually, only one ovum is released at a time. However, if several are released, twins or more can result from fertilisation by different sperm. In this case, the babies are not identical because they have different genetic combinations. These are called **fraternal twins**.

The use of fertility drugs and treatments has resulted in an increase in the number of multiple births. This is because they can affect the ovulation, so that more than one egg is released at a time. Some of these drugs can increase the chance of twins by 25 times and of triplets up to 350 times!

HOW ABOUT THAT!

Which animal has the longest sperm? Not an elephant, whale or human, but a fruit fly. Fruit flies of the species *Drosophila bifurca* have sperm about 5.8 cm long! That's about 20 times longer than their own body and around 1000 times longer than human sperm.

UNDERSTANDING AND INQUIRING

REMEMBER

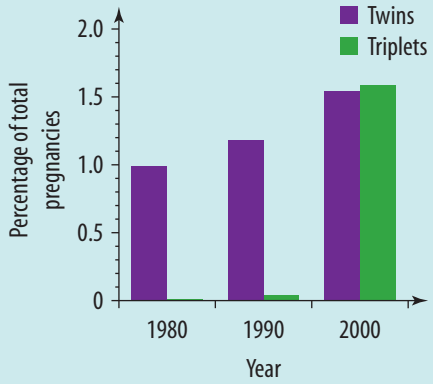
1 Define the term 'sexual reproduction'.
2 Put the following words into a sentence: gametes, sperm, ovum, zygote, fertilisation.
3 Describe the difference between external and internal fertilisation.
4 Draw a labelled diagram of a sperm.
5 Describe the events that take place when the sperm reach a ripe ovum.
6 Construct a Venn diagram to compare sperm and egg (ova) cells.
7 Explain the difference between identical and fraternal twins.
8 Construct a flowchart that includes ovulation, ejaculation and fertilisation.

THINK AND DISCUSS

9 With a partner or in a team, discuss the following questions.
(a) Why is internal fertilisation generally more efficient than external fertilisation?
(b) Why doesn't fertilisation occur each time a couple have sexual intercourse?
Send a team member to other teams to share your discussion points.

INVESTIGATE

10 Find out more about the gametes of at least four different animals. Display your findings either as models or as diagrams on a poster.
11 There is a theory that, by wearing tight jeans, human males may affect the development of their sperm. Find out if there is any scientific evidence to support this theory.



Incidence of multiple births in Australia since 1980 (as a percentage of total number of pregnancies)

Source: Based on ABS data

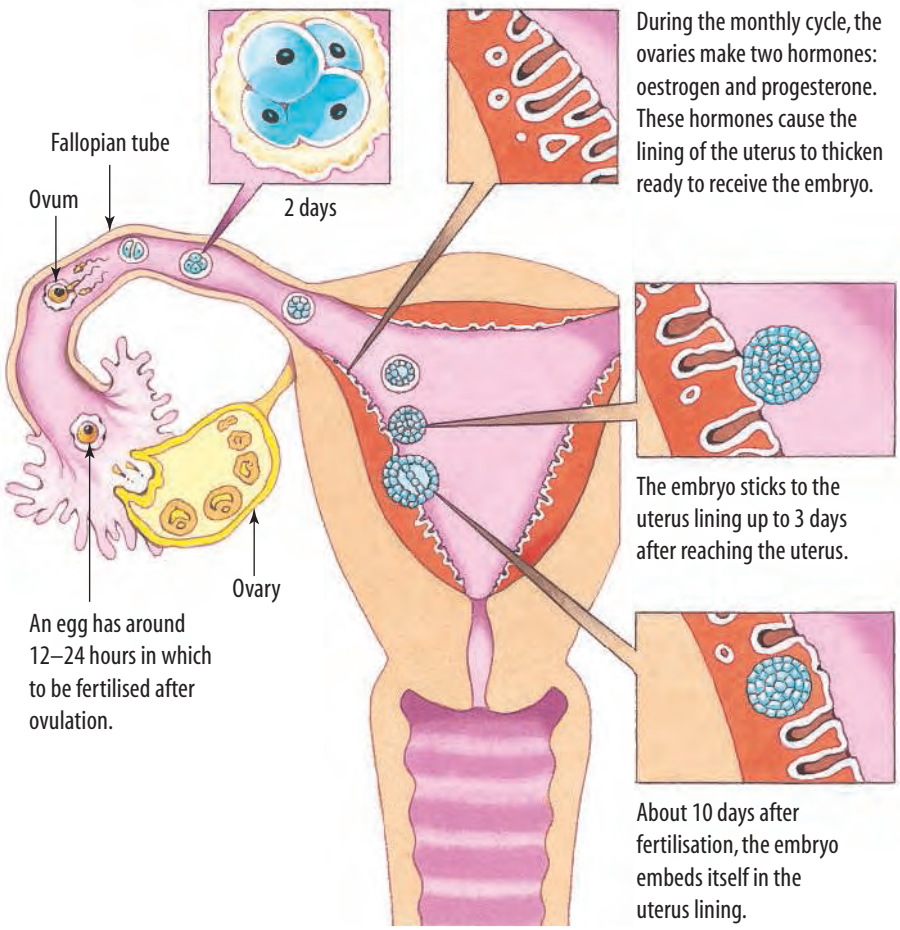
12 Carefully observe the graph above on the incidence of multiple births in Australia.
(a) Suggest reasons for any patterns in the graph.
(b) Suggest what the graph would look like if this year's data was added. Provide supporting information for your suggestion.
13 Research further into either epigenetics or mitochondrial DNA and share your findings with others.

INVESTIGATE AND CREATE

14 Write a story, play or poem about the successful sperm, from ejaculation to when it fertilises the ovum.
15 Design a board game that incorporates information about sperm and eggs.
16 Draw a descriptive timeline that includes: ovulation, ejaculation, sexual intercourse, the various stages of the sperm's travels through the female's reproductive tract, and fertilisation.

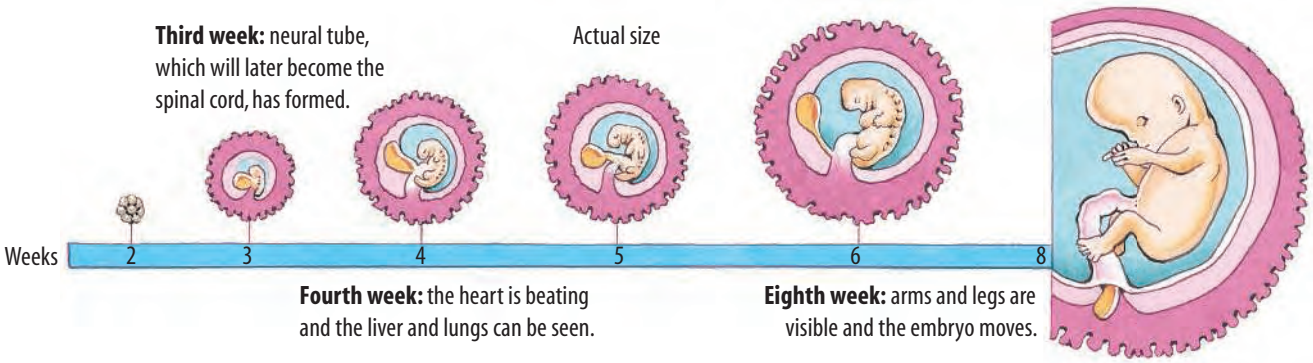
Making babies

Multiplication is the name of the reproductive game. Sometimes one and one can make three!



The first eight weeks

Conception occurs when the egg cell and sperm unite to form a zygote. When the zygote has divided into many more cells, it is known as an **embryo**. About ten days after fertilisation, the embryo completely embeds itself in the uterus lining (endometrium). This process is called **implantation**.



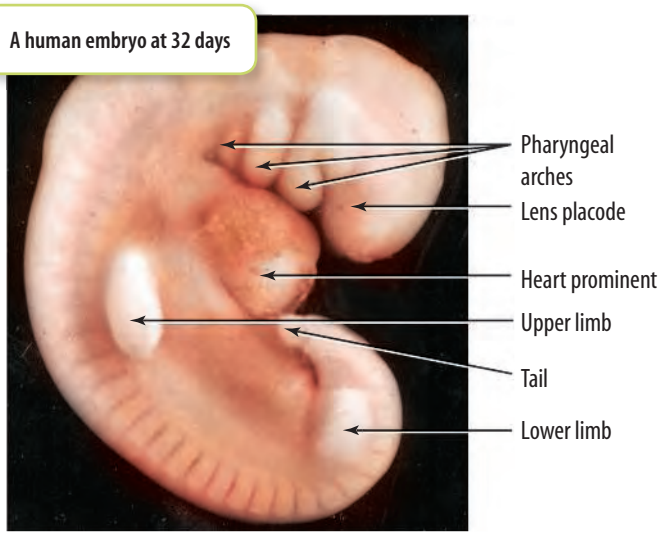
'After eight'

In humans, at about eight weeks, when the embryo has developed a distinct head, arms and legs, it is called a **fetus**. The fetus obtains its nutrients and oxygen through a special organ called the **placenta**. This organ is connected to the mother's blood vessels through the uterus. The placenta also absorbs fetal waste products and acts as a barrier against harmful substances. The unborn child continues to develop inside a sac that is filled with fluid (called amniotic fluid) for the rest of its time within the uterus. The total time spent in the uterus is often called the **gestation period**. In humans this is usually about 40 weeks. If a baby is born before 37 weeks, it is called **premature** and usually requires extra care and assistance.

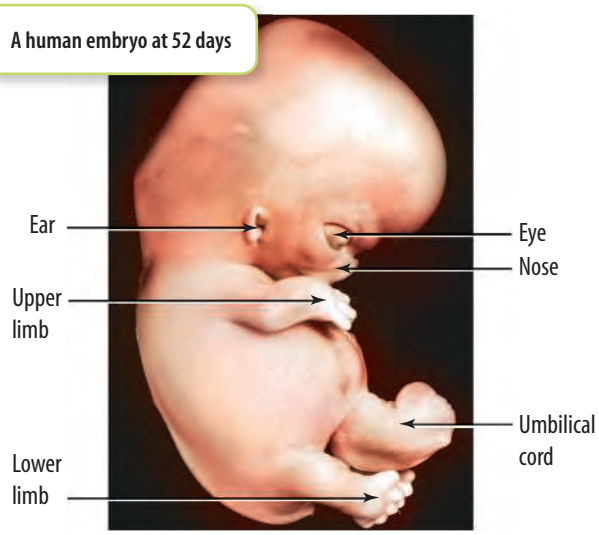
Approximate size of a fetus at different stages of development

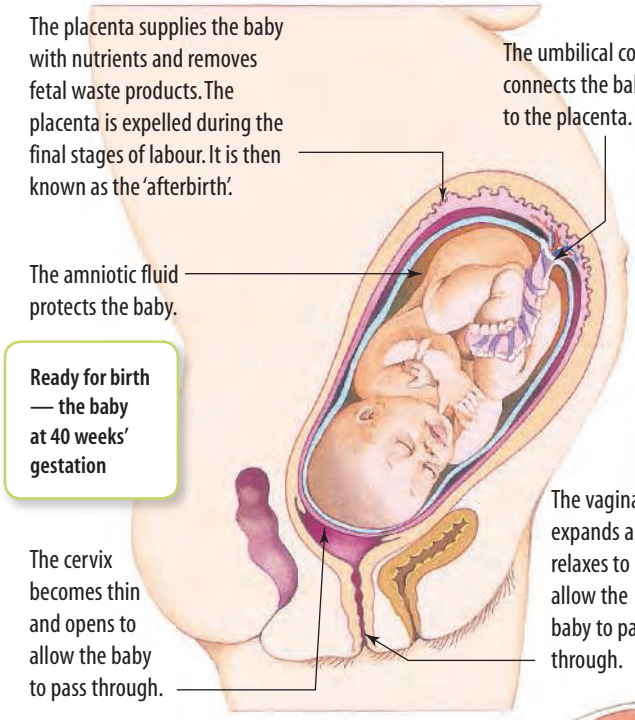
Development (weeks)	Length (cm)	Mass (g)
8	3	2
12	7.5	18
16	16	140
40	51	3400

A human embryo at 32 days



A human embryo at 52 days





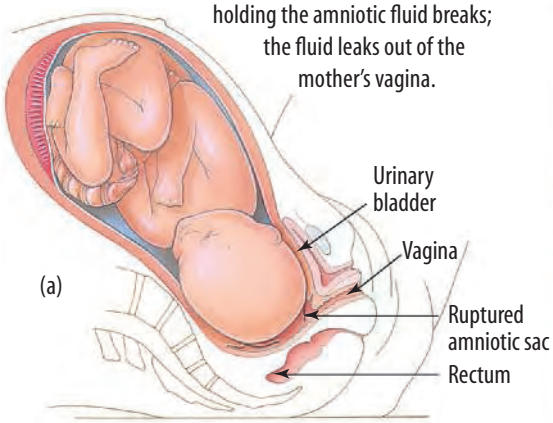
Giving birth

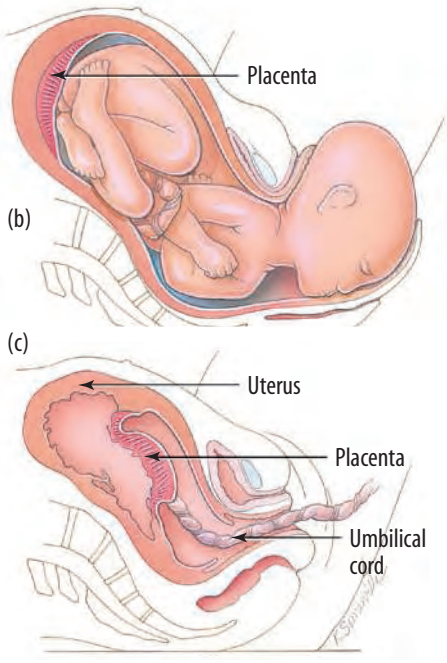
There are three stages involved in giving birth to a baby. Giving birth is usually referred to as **labour** because it can be a lot of hard work for the mother. During the first stage, the cervix gradually widens. In the second stage, the woman feels a strong urge to push with each contraction of the uterus. It is during this stage that the baby is born through the vagina, or birth canal. Usually the baby is born head first. Sometimes, however, the baby is born bottom or feet first; this is referred to as a **breech** birth and is often more difficult. The third stage lasts from the delivery of the baby until the placenta is delivered.

In some cases, the baby or the mother need extra assistance. A **caesarean** operation may be performed in which doctors surgically remove the baby by cutting through the mother's abdomen to her uterus.

(a) First stage

Uterus begins to contract at regular intervals that get closer and closer together. These contractions begin pushing down on the baby. At some point, the sac holding the amniotic fluid breaks; the fluid leaks out of the mother's vagina.





As contractions continue, the cervix stretches open more and more, until it is about 10 cm wide. This stage can last for many hours, especially for first-time mothers.

(b) Second stage

The mother gets a fierce urge to push (a bit like with a bowel motion) every time the uterus contracts. Bit by bit, this pushes the baby further down the vagina (birth canal).

(c) Third stage

The placenta is delivered after the baby is born. By this stage of the pregnancy it is a flattish, dinner-plate-shaped organ that looks a bit like a large piece of liver.

HOW ABOUT THAT!

Oxytocin — the 'trust' hormone

Hormones can have a variety of effects on our bodies. **Oxytocin** is an example of a hormone that not only has the potential to change how we feel, but also has important reproductive roles. This hormone causes the uterus to contract during childbirth and has a key role in breastfeeding. When a baby suckles on the mother's nipple, oxytocin is released in the mother, triggering the 'let down' response in which milk is released for the baby.

Oxytocin is also thought to be involved in the promotion of trust, love, empathy and social recognition. It has been described as the 'cuddle chemical', as it is released when mothers cuddle their babies. The release of oxytocin may also assist in the formation of bonds not only between mothers and their babies, but also between people in close relationships.

With trust comes power! Nasal sprays containing oxytocin have been marketed as 'trust sprays'. These are being advertised as having commercial value as they may contribute to feelings of trust in potential clients and customers. The development of oxytocin nasal sprays also provides an opportunity for researchers to investigate the potential use of this hormone in the development of treatments for specific autism spectral disorders (ASD) and in treatments to increase empathy and learn successful face recognition.

Cuddling and breastfeeding can result in the release of oxytocin, which can promote feelings of trust, love and bonding.

UNDERSTANDING AND INQUIRING

REMEMBER

1 State the differences between a zygote, an embryo and a fetus.
2 List the following in the correct order: birth, fertilisation, ovulation, growth, implantation.
3 In which part of the female reproductive system does the fetus develop?
4 Explain why sexual intercourse doesn't always result in fertilisation and pregnancy.
5 What is the difference between:
   (a) fertilisation and implantation?
   (b) fraternal and identical twins?

USING DATA

6 Construct a graph, using information in this section, to show the changes in length of the embryo from 2 to 8 weeks and the length and weight of the fetus from 8 to 40 weeks.

CREATE

7 Make scale models of the fetus at each age shown in the table on page 186.

THINK

8 Correctly match each key event with its day of occurrence in the menstrual cycle.

Day	Key event	Day	Key event
14	implantation	16	fertilisation
15	first cell division	23	ovulation

9 Suggest why menstruation must stop during pregnancy. What would happen if this was not the case?

INVESTIGATE

10 Research and report on one of the following: endometriosis, prolapse of the uterus, cervical cancer, hysterectomy, ectopic pregnancy.
11 Research and report on one of the following antenatal tests: ultrasound scanning, amniocentesis, chorionic villus sampling.
12 (a) Investigate the commercial availability and uses of the hormone oxytocin.
   (b) In your team, construct a PMI chart based on your findings.
   (c) Discuss the ethics and issues regarding the use of oxytocin in conditions not involving childbirth and breastfeeding.
   (d) If you were on an ethics committee or governing body, what regulations would you suggest be considered concerning the availability and use of synthetic versions of hormones (such as oxytocin)?
   (e) Organise your team's discussion and findings into a format that enables it to be shared with others.

To breed or not to breed

Preventing pregnancies

Conception involves the production of a zygote and its implantation into the wall of the uterus. Techniques that prevent this happening are called **contraception**.

Contraceptives are the devices or substances used to prevent unplanned pregnancies. There are two main types of contraceptives: those that prevent fertilisation taking place and those that prevent the fertilised ovum from implanting in the uterus.

eBookplus eLesson

Methods of contraception
This elesson will help you understand the many different forms of contraception and how effective they are in preventing conceptions.

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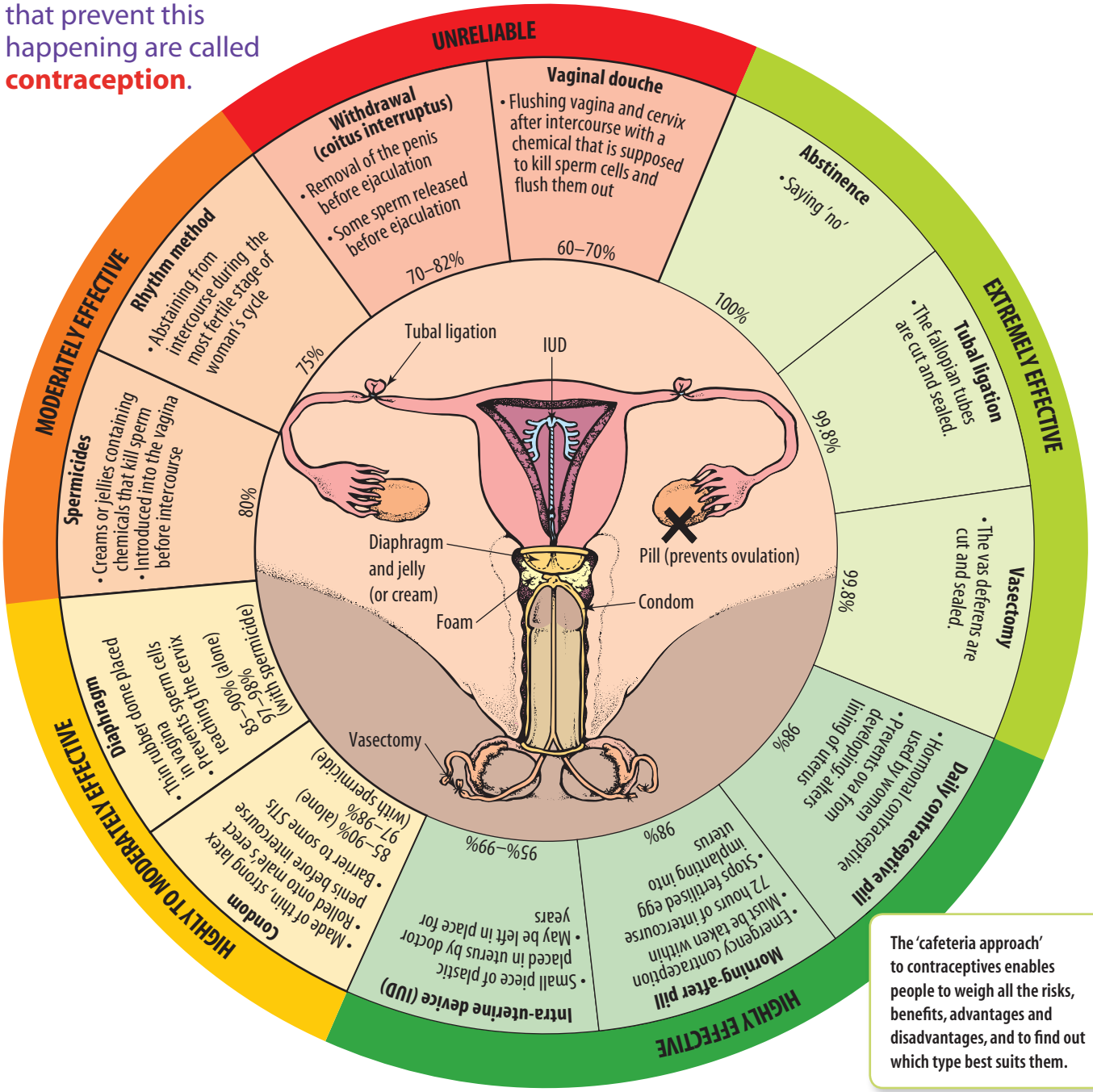


The 'cafeteria approach' to contraceptives enables people to weigh all the risks, benefits, advantages and disadvantages, and to find out which type best suits them.

The World Health Organization estimates that, worldwide, half of all pregnancies are unplanned. The information that follows is given to you so that you are informed and know the facts about a variety of contraceptives. Quite often, television shows and magazines introduce sexual activity to young adults without giving them the full story. This can deliver a distorted message. But remember, the most effective method of contraception of all is to say 'no'!

New and improved products

Throughout history, people have tried to find methods that would enable them to have sex but not make babies — for example, people have tried swallowing tadpoles in spring, using lemons as a 'diaphragm' and using pig intestines as condoms. Because there is still no such thing as the perfect contraceptive, many new products are being invented and tested.

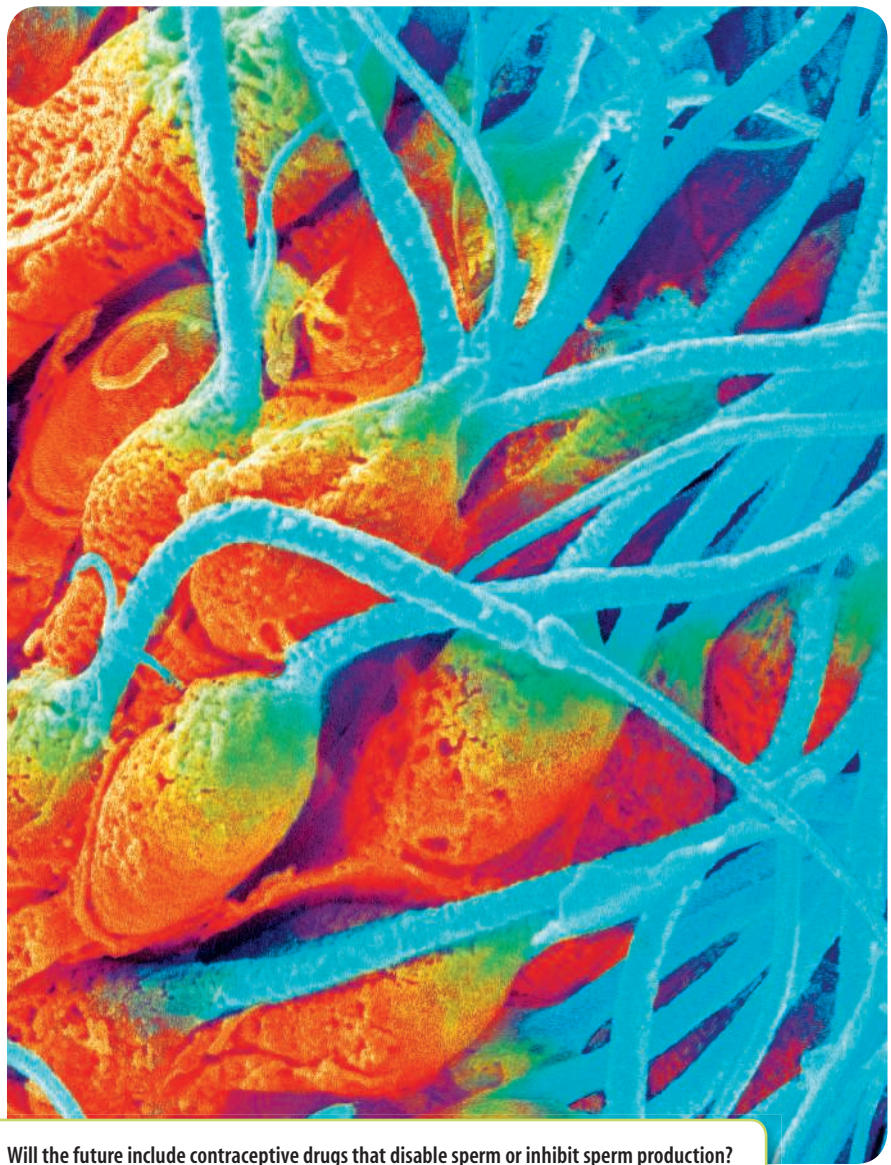
For women, some of these include **transdermal patches** that stick onto the skin and release hormones, **daily vaginal pills** that dissolve into spermicide when inserted into the vagina before intercourse, and the **Filshie clip**, a type of fallopian tube clamp. In some countries, even a female condom is available.

New products for men include **testosterone injections** or implants to reduce sperm levels, **male anti-fertility vaccines** that regulate sperm and testosterone production, **sperm duct plugs** that inject liquid plastic into the vas deferens, **chemical sterilisation**, and **gossypol**, a chemical that reduces sperm production.

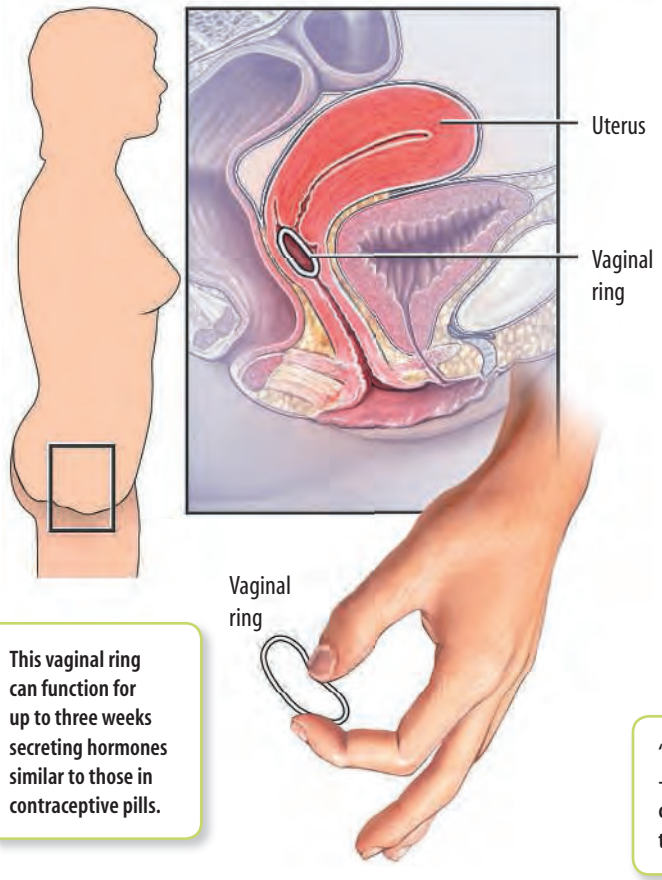
In for the long haul

There are also a variety of long-acting contraceptive methods available. Once 'introduced', these require no further action by the user for a long time. A disadvantage of most of them is that they require medical intervention for insertion and removal. Examples include:

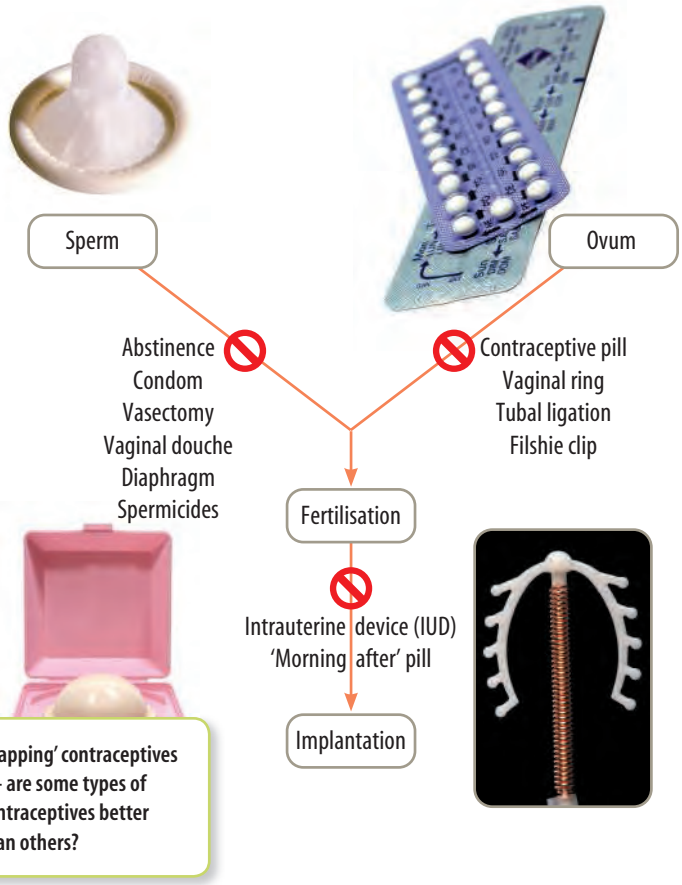
- *Depo injections:* Also known as Depo-Provera, this is a hormone injected into the user's buttock muscles that prevents ovulation for about three months.
- *implants:* A contraceptive implant (about the size of a matchstick) called Implanon is inserted under the skin of the inner, upper arm and prevents ovulation for about three years.
- *hormone releasing intra-uterine devices (IUD):* A Mirena is a T-shaped plastic device that releases hormones, acting directly on the lining of the uterus to make it thin and unreceptive to implantation of the fertilised egg. It also changes the fallopian tube lining, the mucus produced by the cervix and can stop ovulation in some women. It provides continuous contraceptive protection for about five years.



Will the future include contraceptive drugs that disable sperm or inhibit sperm production?



This vaginal ring can function for up to three weeks secreting hormones similar to those in contraceptive pills.



'Mapping' contraceptives — are some types of contraceptives better than others?

UNDERSTANDING AND INQUIRING

REMEMBER

1 Which methods of contraception:
   (a) prevent the sperm from reaching the egg?
   (b) prevent the release of the egg?

2 Construct a table that has six columns, with headings for: the type of contraceptive, a summary of how it works, who uses it (male or female), suggested advantages, suggested disadvantages, and a prediction of how many pregnancies may occur if 100 sexually active, fertile couples were to use it.

THINK

3 After a vasectomy:
   (a) does a male still produce sperm?
   (b) what does the ejaculate contain?

4 After a tubal ligation, does a woman:
   (a) still ovulate?
   (b) menstruate?

5 Suggest reasons why some contraceptives may be more effective than others.

INVESTIGATE AND DISCUSS

6 Research a method of contraception and present your findings to your team or class as a poster, PowerPoint presentation or concept map.

7 Find out about four of the following types of contraceptives and then present your findings with your team as a poster, PowerPoint presentation or concept map.

- Combined oral contraceptive pill
- Progesterone-only pill (or the mini pill)
- Depo-Provera (injectable contraceptive)
- Hormonal implants
- Morning-after pill (MAP)
- Today sponge
- Lng-Levonova IUD
- Vaginal ring
- Female condoms

8 Find out the advantages and disadvantages of each type of contraceptive list above. Present your findings as a matrix (see page 340). Compare and discuss your findings with others in the class.

CREATE

9 Design a 'future' contraceptive, using your imagination and knowledge of reproductive systems. Decide on how you would scientifically test the safety, effectiveness and popularity of your contraceptive. Produce a brochure that promotes your invention.

Reproductive technologies

Making babies is not always easy and simple. Not everyone can make their own babies.

The term **infertility** describes the inability to conceive or carry a pregnancy to a live birth. About 20 per cent of all couples are infertile. One of the commonest causes of infertility is the inability of either the male or the female to produce gametes. Such a person is **sterile**.

Some of the other reasons couples may not be able to have children are listed in the table below. Reproductive technologies have been developed to help people overcome some of these problems.

Some of the reasons couples may not be able to have children

Type of problem	Definition/reason
Gametes	Sperm or ova are not produced in sufficient quantity or quality.
Impotence	Some men cannot maintain an erection during sexual intercourse.
Blockage or damage	Some women may have blockages in their reproductive system (e.g. fallopian tubes), preventing fertilisation.
Miscarriage	The zygote or embryo is not maintained until the full term of the pregnancy.

Artificial insemination (AI)

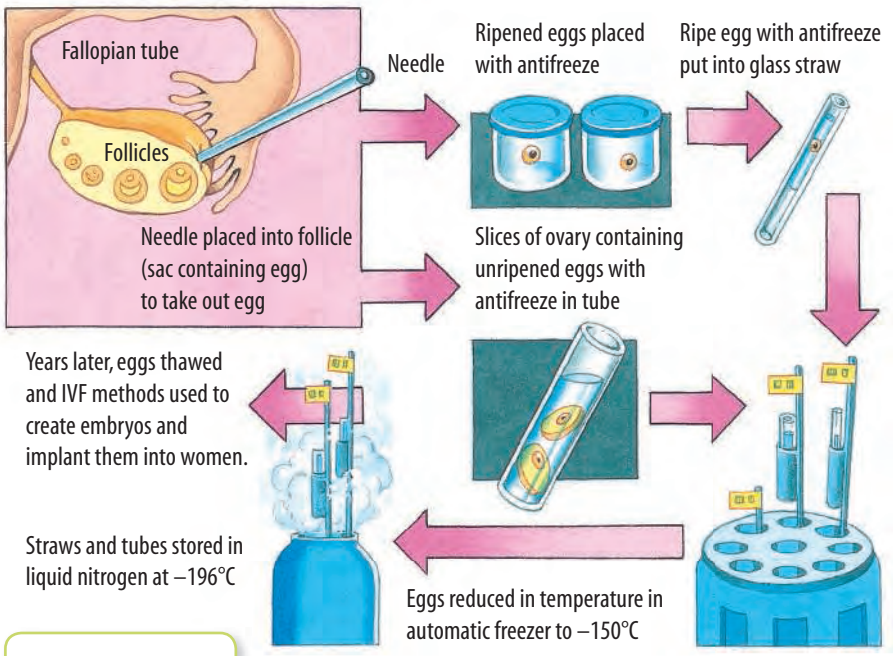
This technique involves injection of sperm into the woman's uterus close to the time of ovulation. The sperm may be collected from her partner, or from another male if her partner is sterile. Artificial insemination has also been used in agriculture in the production of prime farm animals, and in the breeding programs for endangered species.

In-vitro fertilisation (IVF)

In IVF, the sperm and the egg are fertilised outside the female's body. The fertilised egg is incubated until it develops into an embryo, which is then introduced into the female's uterus.

In this technology, eggs are surgically removed using a needle, laparoscope and forceps. A laparoscope has the lens of a microscope. To improve the chances of success, the woman is often treated with drugs that cause super-ovulation, resulting in several ova maturing at the same time (instead of one, as is usually the case). It is possible to freeze any fertilised eggs that are not used so that they may be available at a future time. This could enable 'twins' to be born years apart. Some women may use **donor eggs** (ova from other women).

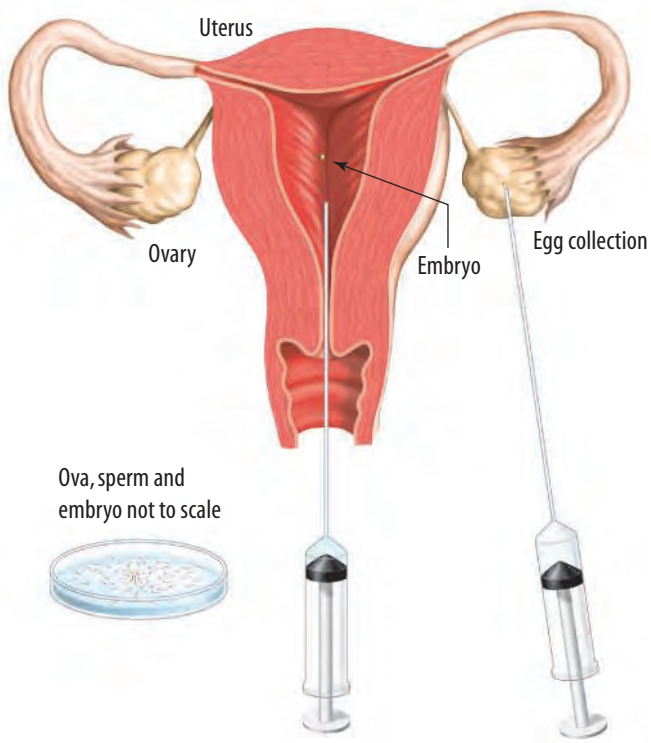
The removed egg is then fertilised outside the mother's body in a small glass tube or dish. The sperm used has been treated to remove its outer protein coat (an event that usually occurs in the female's reproductive tract). The fertilised egg is incubated in the laboratory until it is at



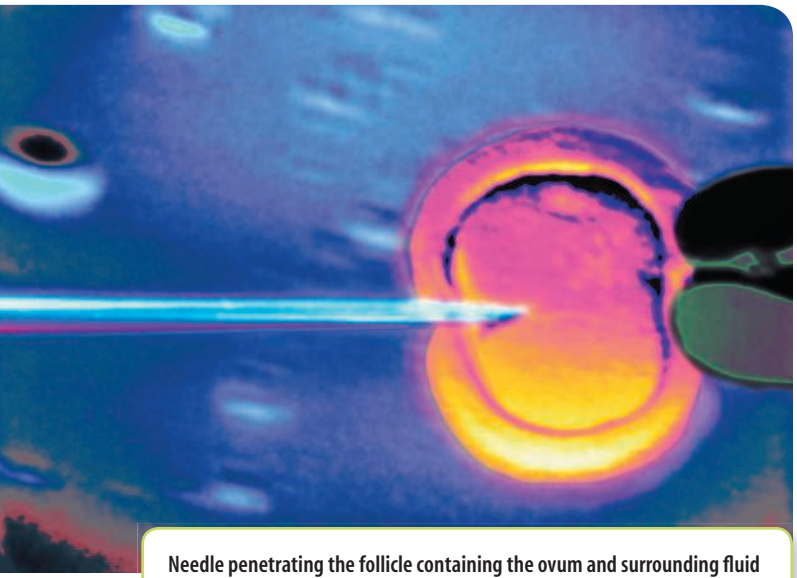
Frozen egg technology

the two- or four-cell stage. A four-cell embryo is obtained at about 35–46 hours after fertilisation.

The embryo is then placed into the woman's uterus for implantation. Babies born using this technique are often referred to as **test-tube babies**. In 1980, Australia's first IVF baby, a girl, was born in Melbourne; the first frozen embryo baby was also born in Melbourne, in 1984.



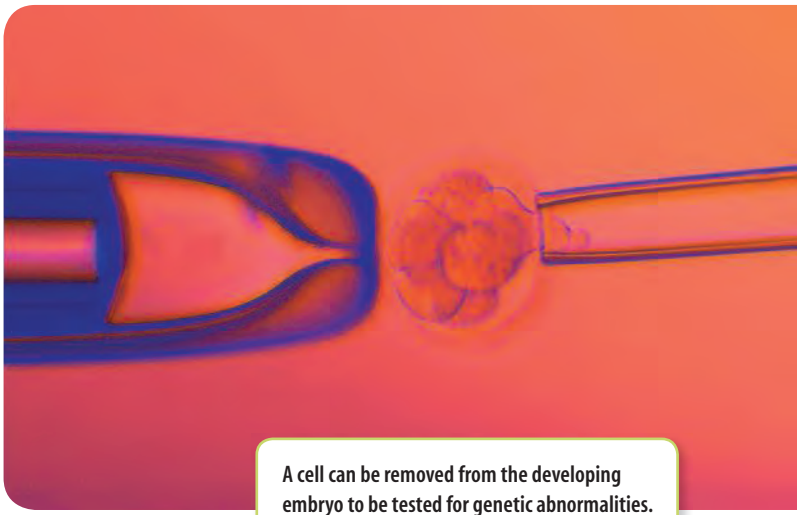
Hormone injections are used to increase ovulation. Collected eggs may be incubated and mixed with sperm to allow the possibility of fertilisation and formation of an embryo. The embryo may be inserted into the uterus. Surplus eggs or embryos may be frozen.



Needle penetrating the follicle containing the ovum and surrounding fluid

Although Louise Brown's conception using IVF in 1978 was considered a miracle of science at the time, she is now one of more than 80 000 Australians who started life in a dish. Louise is now in her thirties and is a mother herself, with her daughter being conceived naturally.

Some women are unable to maintain the growing embryo inside their uterus. A woman may, for example, be born without a uterus. The development of IVF technology has also opened up the field of **surrogacy**. In this situation, eggs are surgically removed from one woman and fertilised using IVF techniques. After this they are placed into another woman who undergoes the pregnancy.

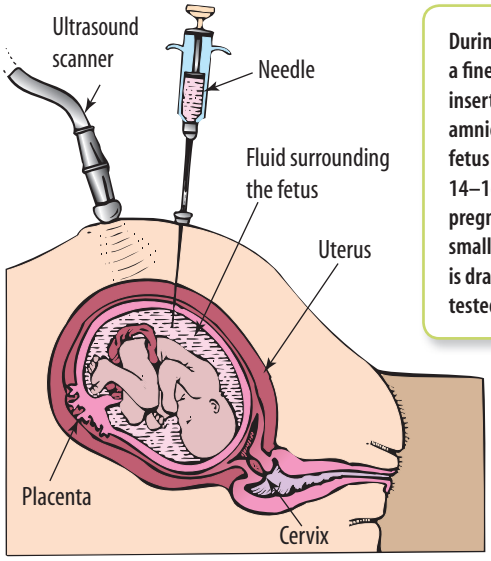


A cell can be removed from the developing embryo to be tested for genetic abnormalities.

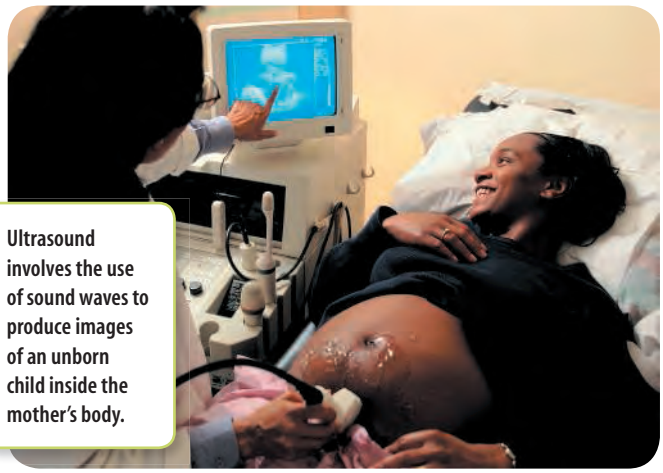
Testing the unborn child

There are a variety of technologies that can be used to test genetic composition and development. Some of these can be performed when the new life is in its very early stages. **Pre-implantation genetic diagnosis** (PGD) may be used to diagnose and exclude genetic abnormalities in embryos before potential implantation.

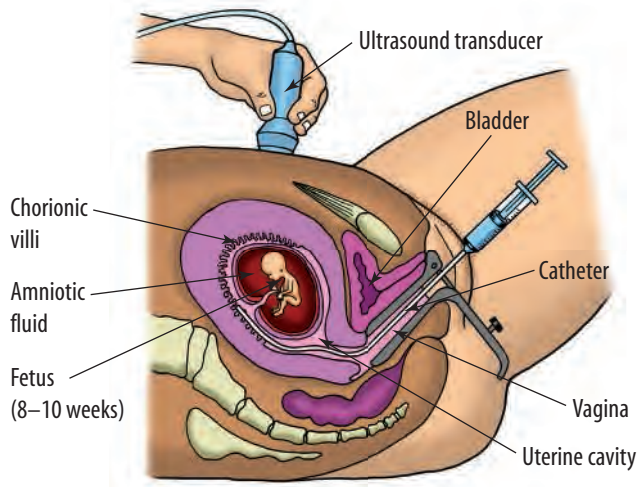
Other techniques, such as **ultrasound**, **amniocentesis** and **chorionic villus sampling** can be used at later stages of development. These techniques enable the gender and a variety of abnormalities to be identified.



During amniocentesis, a fine needle is inserted into the amniotic sac of the fetus at around 14–16 weeks of the pregnancy and a small amount of fluid is drawn out to be tested.



Ultrasound involves the use of sound waves to produce images of an unborn child inside the mother's body.



In chorionic villus sampling, cells from the developing placenta are removed for testing at around 10–12 weeks of pregnancy.

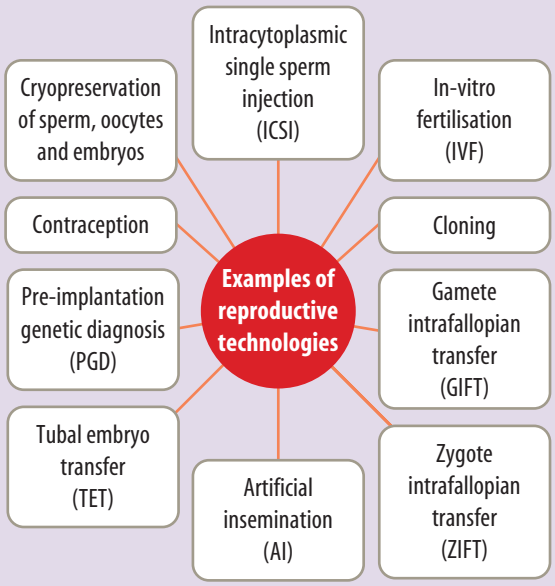
HOW ABOUT THAT!

Cadence Minge, a University of Adelaide researcher, was a winner of South Australia's Young Investigator of the Year award in 2007. Her research provided scientific evidence that high-fat diets could cause infertility in obese women. Her investigation involved using mouse eggs and showed that diets high in fat caused damage to eggs stored in the ovaries. She also found that a particular protein called PPAR-gamma could reverse the effects, but warned that it should not be considered a 'quick fix' for infertile women.

Cadence Minge (winner of South Australia's Young Investigator of the Year award in 2007)

HOW ABOUT THAT!

There are many different types of reproductive technologies. While assisted reproductive technologies (ART) can be used to treat infertility, other types (such as contraceptives) may be used to reduce fertility. Other types of reproductive technologies may be used to determine the likelihood of developing a particular genetic disease or to increase the number of offspring with particular features.



What's the difference between a GIFT and a ZIFT? Which of the reproductive technologies in this figure increase fertility and which decrease it? What's cryopreservation and why bother with it?

UNDERSTANDING AND INQUIRING

REMEMBER

1 Discuss the techniques that would help a couple reproduce if:
   (a) the male was infertile
   (b) the male was impotent
   (c) the female had blocked fallopian tubes
   (d) the female had a history of miscarriages.

2 Distinguish between:
   (a) artificial insemination and in-vitro fertilisation
   (b) ultrasound and amniocentesis.

3 Outline, in point form, the steps involved in IVF.

4 What are 'test-tube' babies? Is this an adequate name for them? Explain.

THINK, INVESTIGATE AND DISCUSS

5 (a) In groups of four or more, discuss each issue statement in the table below.
   (b) Write a list of people's 'gut reactions' or immediate responses to each statement.
   (c) Make a list of arguments for, and a list of arguments against, each statement.
   (d) Suggest what factors influenced your opinions on these issues.
   (e) Did the opinions differ between members of your group? Suggest reasons why.
   (f) Report your findings back to the class, or organise a debate.
   (g) Write a summary paragraph about the class's overall response to each statement.

6 Who should decide who is entitled to access to these technologies? Discuss this with your team and report back to the class.

7 What are the risks linked to reproductive technologies?

8 (a) Find out about the South Australian Young Investigator of the Year award and outline examples of scientific research that winners have been involved in.
   (b) Find out more and report on one of these research areas.

9 (a) Find out similarities and differences between the fields of obstetrics and gynaecology.
   (b) Select a topic that interests you in the area of reproductive technologies and investigate and report on research in that field.

10 Research and report on the scientific contributions of two leading reproductive technology pioneers:
   (a) Carl Wood (IVF pioneer, assisted reproductive technology)
   (b) Alan Trounson (IVF and stem cell pioneer).

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11 Use the **IVF** weblink in your eBookPLUS to watch an animation of in-vitro fertilisation.

12 Developments in reproductive technology rely on scientific knowledge from different areas. Find examples that provide evidence for this claim.

work sheet 5.4 IVF — discussing the issues

Technique	Issue statement	Your opinion (Explain your response with arguments for and against the issue.)
AI	• Sperm should be used only from males with a high IQ, blue eyes and red hair. • All women should be artificially inseminated with sperm selected by their parents.	
IVF	• The IVF program is too expensive and should be abandoned. • IVF technology should be used to build a superior race.	
Donor gametes; surrogacy	• Donors and surrogates should be anonymous and have no rights over the offspring produced. • Sperm should be collected from all males at the age of 18 and only this is to be used for fathering children.	
Frozen embryos	• These embryos should be available to other couples if they are not used within six months. • These embryos should be developed so that they provide a supply of blood and organs for transplants.	
Ultrasound; amniocentesis	• These tests should be made compulsory for all women. Any abnormalities should result in immediate removal of the fetus. • These techniques should be used to select the gender of the child.	

Reproduction in the news

Research in the area of reproductive technology has brought along rapid change. There is a big difference between what is scientifically possible and what is socially acceptable.

The news snippets in this section provide examples of situations where the use of reproductive technology has raised ethical, social, legal or economic issues. Each snippet is a summary of a news story that was either published in a newspaper or was presented on the news.

UK woman pregnant by dead husband's sperm

Semen can be collected from a recently deceased man and frozen for later use, but is it ethical to do so?

Diane Blood confirmed that she was pregnant by her dead husband's sperm. Diane's husband died from meningitis in 1995. Some sperm samples were collected and frozen. Diane was told that she could not use the sperm samples for artificial insemination because her husband had not given his consent in writing before he died. She went to court and won the right to use the semen samples.

Source: BBC News, 28 June 1998

At 67, Romanian becomes the oldest mother

Adriana Iliescu gave birth at age 67.

Adriana Iliescu had IVF treatment using donor eggs. She started fertility treatment at the age of 58. After many years she finally succeeded in falling pregnant with twins. One of the twins died in the womb; the other baby was then delivered by caesarean section 6 weeks before the due date weighing 1.4 kg.

Source: The Age, 18 January 2005

Mother urges legalisation of surrogacy

Surrogacy is when a woman carries and delivers a baby for a childless couple. In some cases sperm from the father is used to artificially inseminate the surrogate mother. In other cases an embryo from the childless couple is produced by IVF and then transferred into the womb of the surrogate. In commercial surrogacy the surrogate is paid, sometimes large amounts of money, to carry the child. Altruistic surrogacy does not involve the exchange of money. A friend or sister might carry a child for a couple for example, and not expect payment in return. At the time the article went to press, altruistic surrogacy was legal in all states except Queensland where women could be fined or sent to jail for acting as a surrogate. A hearing was under way to decide whether it should become legal in Queensland.

Source: The Sydney Morning Herald, 7 July 2008

India's baby farms

Dr Kakoli Ghosh Dastidar works in a clinic in India where local women are paid to act as surrogates for other couples.

Indian clinics specialising in surrogacy are offering rich childless couples from around the world the opportunity to use a poorer Indian woman as a surrogate. The women are paid to act as surrogates. They live together while they are pregnant and they receive regular health checks and have all their meals prepared. For American couples (another country where commercial surrogacy is legal) the cost of an Indian surrogate is much less than an American surrogate.

Source: Sydney Morning Herald, 6 January 2008

Designer babies

Professor Julian Savulescu, an ethicist from Oxford University, argues that parents should be able to use genetic testing combined with IVF to choose the genetic characteristics of their children. Currently it is possible to test embryos created by IVF to find out which embryos carry certain disease-causing genes. Embryos found to carry the genes are not implanted. Professor Savulescu argues the technique should be further developed to allow parents to select genes for anything ranging from hair colour to intelligence or sporting ability.

Source: Channel 9 'Today' show, 7 August 2007

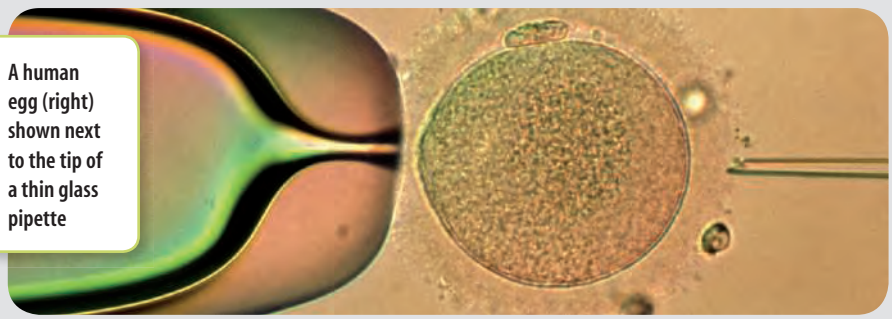
Should parents have the right to select certain characteristics in their children?

Freezing eggs is 'highly experimental'

The option of freezing some eggs is increasingly offered to women for a variety of reasons. Treatment for certain types of cancer can make women infertile or damage their eggs. Having some eggs collected and frozen before starting cancer treatment would give these women a chance to have children after they recover from the cancer. For women who have not met the right partner or do not yet feel ready to be mothers by the time they reach their late thirties, egg freezing might offer the possibility of extending a woman's reproductive years.

The chance of producing a baby from frozen eggs is not very high at this stage. In 2007 the American Society for Reproductive Medicine calculated that for every 100 frozen and thawed eggs only 2 to 4 pregnancies would result. Eggs are more difficult to freeze than semen or embryos because they contain more water and ice crystals can form inside the egg.

Source: Sydney Morning Herald, 26 October 2007



A human egg (right) shown next to the tip of a thin glass pipette

Parents sue over IVF son: Report

A Victorian couple are suing doctors at an IVF clinic. The couple decided to use IVF to conceive their child because they wanted to avoid giving birth to a child with haemophilia. The mother knew she was carrying a gene for haemophilia. Haemophilia is a disease where blood does not clot properly. A person who has severe haemophilia will usually require a transfusion of a special component of blood any time they have even a minor injury such as a cut or bruise. If a woman is a carrier for haemophilia, she does not have haemophilia herself. If she has a daughter and the father does not have haemophilia, the daughter will not have haemophilia either. If the same couple have a son, however, there is a 50 per cent chance that he will have haemophilia.

The couple in this news story used IVF because they wanted the doctors to test the embryos to find out whether they were boys or girls before transferring them to the mother's womb. The doctors made a mistake and transferred a male embryo. The couple gave birth to a son who has severe haemophilia.

Treatment for haemophilia usually includes regular transfusions of a product obtained from donated blood.

The couple are suing the doctors who carried out the IVF treatment. They are arguing that the unexpected arrival of a boy caused them shock and anxiety. They also want to be compensated for the cost of medical treatment for their son as well as the pay they have lost as a result of not being able to go to work when their son has needed treatment.

Source: ABC News, 23 March 2008

UNDERSTANDING AND INQUIRING

REMEMBER

1 Define the following terms:

surrogacy, surrogate mother, legalisation, altruistic, commercial.

2 Outline some situations where women may consider having their eggs frozen.

3 What is the chance of producing a baby from a frozen egg? Why is the success rate so low?

THINK

4 Discuss whether there should be an age limit for IVF treatment. Should this age limit apply to the mother only or to both parents? Justify your answer.

5 Create a PMI chart about the following statement:
A woman should be allowed to use her dead husband's sperm to conceive a child.

6 Using IVF and genetic testing it is currently possible for parents to choose certain characteristics in their children. The technology can be used to screen out certain genetic diseases and to select the sex of the child. In the future it may be possible to select a much greater number of characteristics.
   (a) Discuss whether this particular technology is harmful or beneficial.
   (b) Should parents be allowed to select any characteristics for which there is a test available or should there be restrictions on the characteristics that parents can select? Justify your answer.
   (c) IVF and genetic testing are expensive procedures, so they may not be available to poorer couples. Explain how this could have an impact on society.

INVESTIGATE

7 Use EBSCO or another database to locate other news stories about reproductive technology. Summarise the key points in each article.

Form and function: Comparing connections

Reproduction can be a risky business — but when the stakes are high it can be worth it! Some animals have some pretty tricky ways of reproducing . . .

Big families

Many organisms produce more eggs than can survive. Imagine what would happen if the 2000 eggs laid by a female house fly all survived! Environmental factors and predators may cause the death of many offspring before they get a chance to develop to the stage at which they themselves can reproduce. Sea urchins, for example, may discharge millions of gametes into the sea at one time. This coordinated timing of the release increases the chances of fertilisation occurring. However, most of the young sea urchins die. These deaths may be caused by many factors, such as competition for food and resources, and predation by other animals. If this reduction in the numbers of sea urchins did not occur, they would soon over-populate the oceans. A high juvenile death rate is quite common in many other organisms.

Dad's having a baby

Seahorses are very unusual fish, especially when it comes to making babies! It is the female that inserts part of her body (an ovipositor) into the male. She pumps eggs into a pouch at the front of his body and he then fertilises them with his sperm. Labour can sometimes take two days. Dad gives birth to 50–100 little seahorses, squeezing them out one at a time. No wonder he's called a big-bellied seahorse.

There are some amazing stories to tell about other types of seahorses. The male *Photocorynus* seahorse never grows larger than 10 cm and leads a parasitic life in which he is permanently attached to the female, hanging on by his mouth! This is useful to the female because it means that she doesn't have to search dark ocean depths to find a mate when her eggs are ready for fertilisation.

Male *Hippocampus abdominalis* seahorses try to get females to select them to carry eggs by inflating their pouches into a white balloon.

Guess who's coming to dinner?

In some fish species in which the male is in charge of protecting a clutch of eggs, it is not unusual for him to indulge in eating some of his own offspring. Honey, I ate the kids, indeed!

This trend also appears in some spider groups. The male Australian red-back spider, for example, is usually eaten by his sexual partner while mating with her. He is even considerate enough to position his body directly in front of her jaws after he has inserted his coil-shaped sexual organ into her. Male red-backs have a short lifespan; locating a female is extremely competitive and often the tip of their sexual organ breaks off during sex!

Recent studies have found that males that are consumed increase their chances of fertilising the female's eggs. By being eaten, they distract the female so that they may mate for longer. It was found that males that were eaten were able to mate for 25 minutes compared with 11 minutes for those that escaped. Hence, the eaten males had twice the chance of fertilising the eggs with their sperm. So, although being eaten for dinner seems like a high price to pay for sex, it does have some long-term rewards.

Some male damselflies have a penis with a special hook on the end. He uses it to remove other sperm left inside his mate by previous lovers before he makes his own deposit.

Did you know that . . .

- Some reptiles and rodents actually 'cement' up the female's genitalia by using some of the semen, which sets into a hard plug, not allowing other sperm to get in.
- Male starworms are 'live-in lovers' spending their entire lives within the female's vagina. Her eggs are fertilised by these parasitic males (which live off her vaginal fluids) as soon as they are released.
- Some butterflies have eyes on their genitals to help guide the hooks and claspers of the male to the appropriate nooks and crannies in the female during copulation.
- The Australian gastric brooding frog (now thought to be extinct) swallowed its externally fertilised eggs and then developed them in its stomach. A special chemical produced by the eggs stopped them from being digested. More than 25 little baby frogs would crawl out of the female's stomach and into her mouth.

Sending out signals

USING SMELL

Chemicals called **pheromones** can play an important role in communications between members of the same species. This type of communication makes it very easy for animals to locate a mate, even in sparsely populated areas.

When a female dog is about to ovulate, she comes 'on heat'. During this time she releases a pheromone into her urine to notify male dogs that she is ready for mating. Likewise, female moths use scented chemicals that sexually attract male moths from as far away as 8 kilometres.

USING LIGHT

Fireflies can make part of their body glow different colours. A chemical reaction produces a bright yellow, green or blue colour, which is used to help males and females find each other so that they can mate. Not all females, however, have reproduction on their minds. Females of a particular type of firefly have a different activity in mind. They flash their glowing abdomens on and off in a particular pattern, usually suggestive of a mating invitation. Sadly, instead of a romantic rendezvous, the males become a tasty meal.

USING SOUND

Whales may become separated by long distances, so in order to reproduce it is important that they can communicate. The male humpback whale sings a song during the mating season to advertise his sexual availability to females.

Birds also use their songs to attract potential mates. Frogs and crickets may not sound so melodic but they have their own way of making it known that they are available for sex. Male crickets make their chirping song by

rubbing their forewings together. Often they build their own version of a stereo amplifier by digging an underground nest with a twin-horned tunnel entrance. By sitting at the junction of the horns they can beam out their message loud and clear for all to hear.

Tammar trends

Researchers are studying the reproductive biology of the Tammar wallaby — this may help us to understand more about ourselves.

A baby Tammar wallaby is born about 26 days after conception. At birth, it weighs only 400 mg (about the size of the end of your little finger), and is blind and hairless. After leaving the birth canal, it crawls up into its mother's pouch and attaches itself to one of her teats. At this stage, its external sex organs have not yet developed; researchers already know that these develop in stages quite different from those in many other mammals.

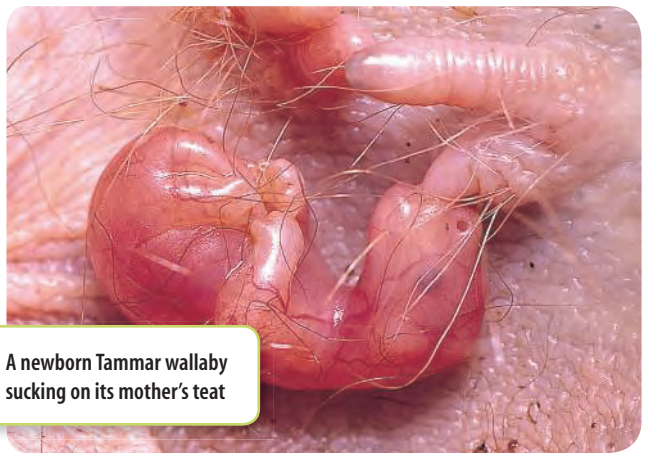
After suckling for about five months, it emerges from the pouch as a young joey. Although a joey can continue to suckle for up to a year, the mother can suckle another wallaby at a different stage of development at the same time. She does this by simultaneously producing two different types of milk. Research on how she does this could help us to improve milk production in farmed animals and our own human nutrition.

Will Tammar wallabies provide clues to our future reproductive technologies?

The mother Tammar wallaby can suspend the development of a fertilised egg until its older brother or sister has left the pouch, or until environmental conditions are more suitable. Finding out how she achieves this may help us develop new fertility and development technologies for other mammals, including humans.

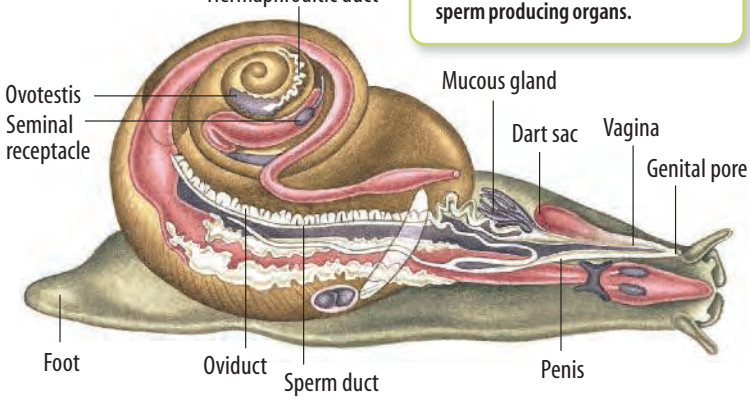
Get a look at that!

Did you know that ancestral reptiles were the first vertebrates to have a penis and that snails contain both male and female reproductive organs? While there is considerable diversity in the organisation of reproductive systems in organisms, there are also patterns and similarities. Although reproductive organs may appear structurally different, they often perform similar specialised functions that enable their species to survive and reproduce. In the figures of the snail and the turtle below, can you identify similarities to our human reproductive systems? If so, what are they?



A newborn Tammar wallaby sucking on its mother's teat

Snails are **hermaphrodites** because they have both egg-producing and sperm producing organs.



UNDERSTANDING AND INQUIRING

REMEMBER

1 Explain why a male red-back spider has a difficult life.
2 Describe why male seahorses are unusual fish.
3 Why didn't the babies in the Australian gastric brooding frog get digested in their mother's stomach?
4 Describe one way in which the following males may increase the chances of their sperm fertilising a female gamete:
   (a) some butterflies
   (b) starworms
   (c) damselflies
   (d) some reptiles and rodents.
5 What is the name of the group of chemicals that can play an important role in communications between members of the same species?
6 Suggest three ways in which smell is important to reproduction.
7 What does it mean when a dog is 'on heat'?
8 How do fireflies advertise their 'sexual availability'?
9 Which animals use sounds as a key invitation for a sexual interlude?
10 Describe what the Tammar wallaby looks like when it is born.
11 Outline some ways that Tammar wallaby research may assist studies in reproductive biology.

THINK AND DISCUSS

12 Why is reproduction worth the 'risks' that may be involved?
13 Why is internal fertilisation generally more efficient than external fertilisation?
14 Describe three ways in which animals may increase their chance of successful reproduction by having specialised reproductive structures or techniques.

INVESTIGATE

15 Find out more about the reproductive systems and mating behaviour of two different animals. Draw up a summary table to describe how are they similar and how are they different.
16 Research the reproductive system of an animal of your choice. Describe how it reproduces and draw a diagram of its reproductive parts. Present your information in a poster.
17 Research some other methods that plants and animals use to increase their chances of producing offspring. Report your findings to the class.
18 Find out more about Tammar wallaby research and present your findings in a PowerPoint presentation, mind map, newspaper article or poster.
19 What is a hermaphrodite? Suggest possible advantages and disadvantages of this condition.
20 Find out more about the evolution of reproductive structures in vertebrates, and report to others on current scientific research in this field.
21 Research the reproductive systems of at least three different animals and then suggest modifications to the design of reproductive systems that could improve their efficiency.
22 (a) Investigate the reproductive systems of the following animals so that you can complete the following table.

Features of:	Mammal	Fish	Turtle	Snail	Insect
Gametes					
Male reproductive structures					
Female reproductive structures					
Fertilisation					

   (b) Comment on the (i) similarities and (ii) differences between animals recorded in your table.
   (c) Which animals are most similar? Which animals are most different? Suggest possible reasons for this pattern.
   (d) Identify a reproductive research question that could be investigated for each animal.
   (e) Select one of the animals and build a model of its reproductive system.

CREATE

23 Write a story, play or poem about the life cycle (from gamete production to death) of an animal of your choice.
24 Make up a crossword with some amazing reproductive stories discovered from your own research.
25 Design a new breed of organisms. Make your 'organisms' out of plasticine or bread dough. Create a booklet that describes their lifestyle, how they find their mates and how they reproduce.

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26 Use the **Animal video** weblink in your eBookPLUS to access the National Geographic video site. Type the word 'courtship' into the search bar to view examples of courtship displays. List some animals that carry out courtship displays.

5.9 SCIENCE UNDERSTANDING

The sex life of plants

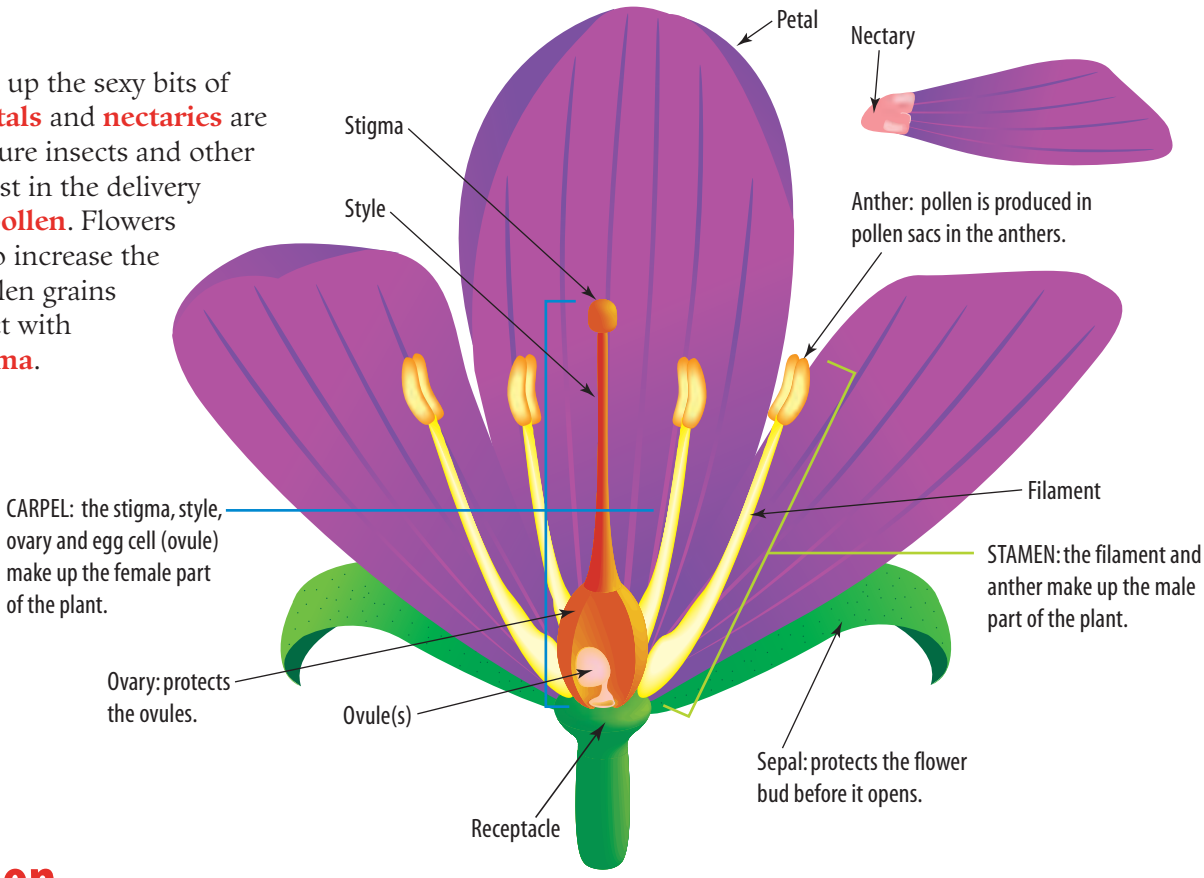
Like animals, many plants can reproduce sexually. Flowering plants (angiosperms) have their reproductive structures located in their flowers.

eBookplus eLesson

Growing plants in Australia
This video lesson is presented by a top Australian horticulturalist and provides you with tips for successfully growing plants in Australia. Watch this video as an introduction to your experiments with plants.
eles-0055

Flowers

Flowers make up the sexy bits of plants. The **petals** and **nectaries** are often used to lure insects and other animals to assist in the delivery of 'sperm' or **pollen**. Flowers are designed to increase the chances of pollen grains making contact with the sticky **stigma**.

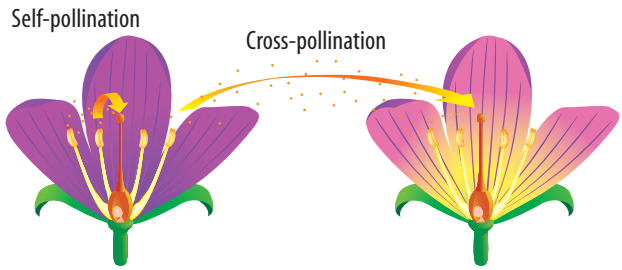


Pollination

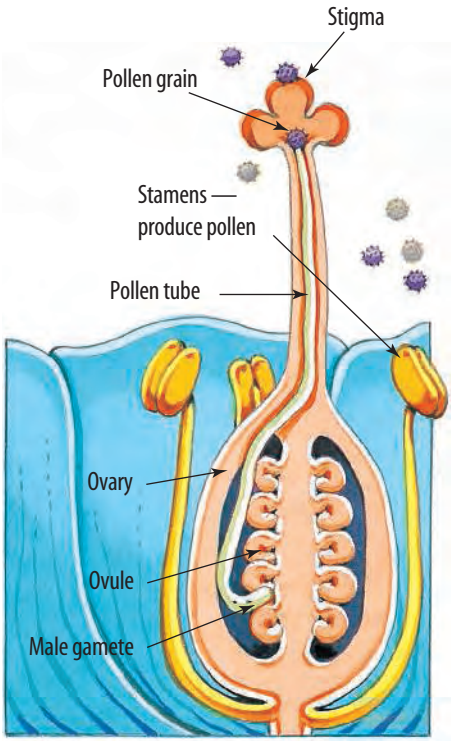
Pollination describes the way in which pollen grains reach the stigma. Plants may pollinate themselves (**self-pollination**). More often, however, they obtain the pollen from the flower of a different plant of the same species (**cross-pollination**). Cross-pollination increases the variation among the offspring and gives them a better chance of survival. The pollen grains may be transferred to other flowers by wind, insects and other animals.

Insect-pollinated flowers usually have attractive, brightly coloured petals and nectaries. The pollen grains themselves may be in a shape that makes them become easily attached to the insect.

Wind-pollinated flowers are usually less conspicuous and have no large scented petals or nectar. Their shape enables small, light pollen grains to be shaken from the plant and carried away with even the slightest gust of wind. The **anthers** hang outside the flower and the feathery stigmas spread out to catch airborne pollen grains.



The difference between self-pollination and cross-pollination



Pollination

As in animals, only a few of the pollen grains produced actually fertilise an egg cell. Pollen grains that reach the stigma of a flower become trapped by a sticky, sugary fluid, that provides them with nutrients. This fluid also triggers the pollen grain to burst open and develop a long hollow tube called a **pollen tube**. This tube grows down through the style until, finally, it reaches the **ovule**. It is here that the male gamete moves from the pollen grain and swims towards the ovum. If it fuses with the ovum, fertilisation has occurred and a zygote is formed.

Plant babies

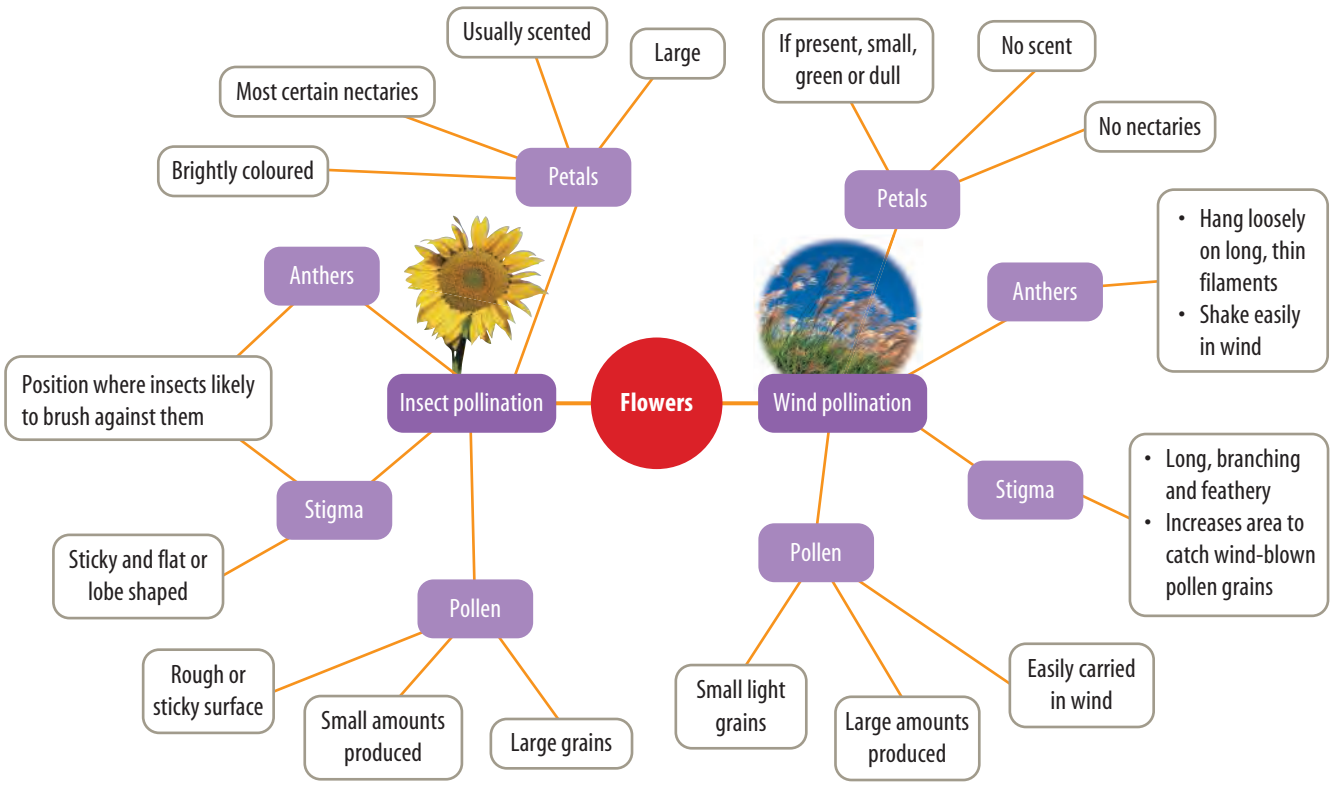
Inside the ovule, the fertilised egg, or zygote, divides into a little ball of cells that becomes an embryo. Special tissue called **endosperm** surrounds the embryo and supplies it with food. The ovule becomes the **seed**, and tissue forms around it to provide a protective seed coat. During the formation of the seed, the ovary expands and turns into a fruit.

Eggs, embryos, seeds and fruit

Are you aware that when you bite into an apple, cherry or orange you are actually eating the enlarged ovary of the plant? Did you know that these swollen ovaries contain the plant's 'babies' in their embryonic form? The plants are using you as a way of distributing their 'young' out into the world.

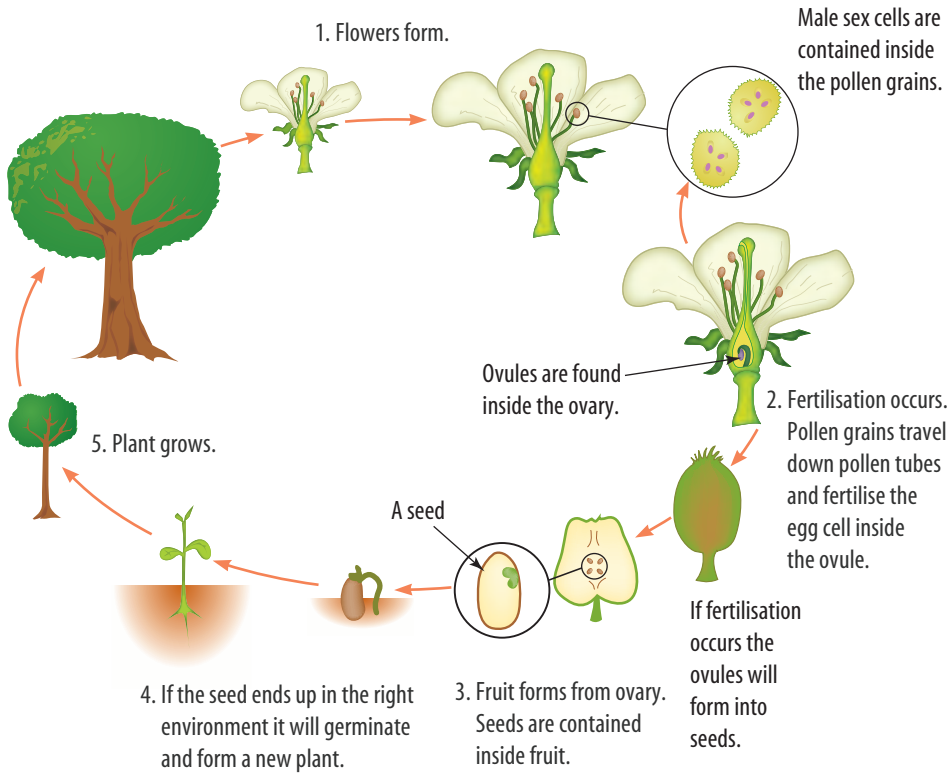
Once the flower has done its job and the egg cell has been fertilised by the pollen nucleus, another sequence of events takes place. The fertilised egg, in the middle of the ovule, divides into a little ball of cells that becomes an embryo. Special tissue called endosperm surrounds the embryo and supplies it with food.

The ovule becomes the seed and tissue forms around it to provide a protective **seed coat**. During the formation of the seed, the ovary expands and turns into a **fruit**.

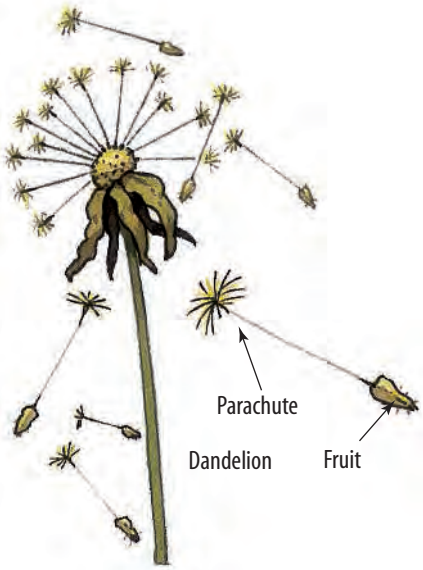


Seed dispersal

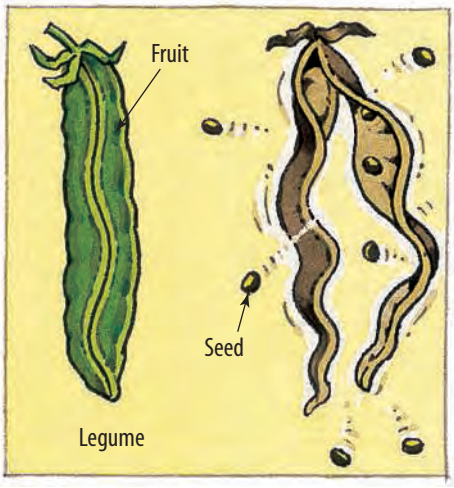
One of the main jobs that fruits do is to help **disperse** or spread the seeds. There is a variety of ways in which plants disperse their seeds: dispersal may involve animals, including birds (such as in tomatoes, grapes and apples); water (such as in coconuts); or wind (such as in grasses and dandelions). Some plants can disperse their seeds by themselves. For example, the fruits of some plants in the pea family (legumes) split open suddenly when they are ripe and dry, throwing the seeds out for long distances.



The life cycle of a flowering plant



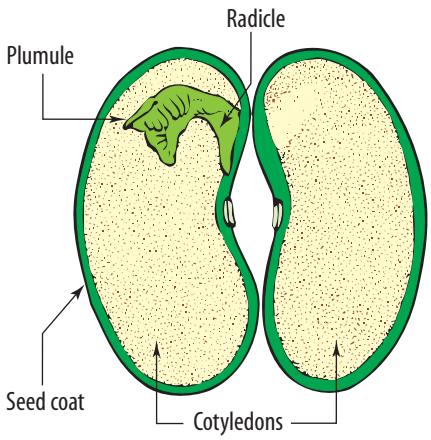
Wind dispersal (*top*) and self dispersal (*bottom*)



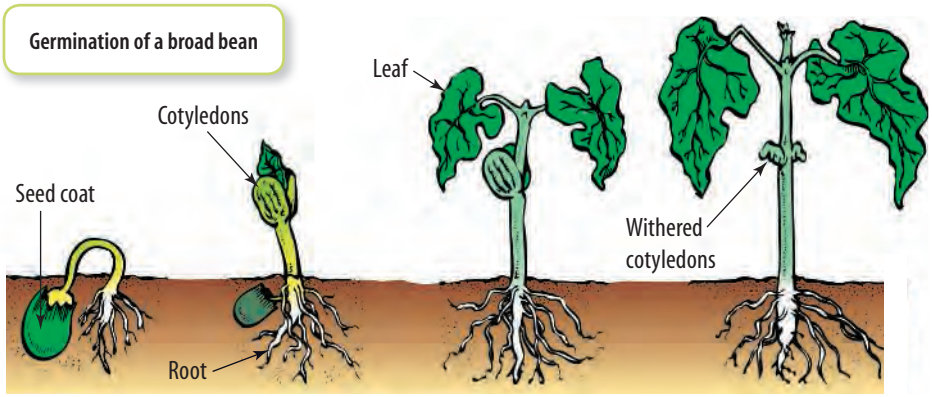
Seeds and germination

The embryo, inside the seed, is made up of three different parts: the baby shoot (**plumule**), the baby root (**radicle**) and one or two thick, wing-like **cotyledons**.

When the conditions are right, the seed bursts open and a new plant grows out. This process is called germination. When **germination** is complete, the embryo has become a young plant or **seedling**.



Germination of a broad bean



INQUIRY: INVESTIGATION 5.3

What's in a flower?

KEY INQUIRY SKILLS:

- planning and conducting
- processing and analysing data and information

Equipment:

flowers

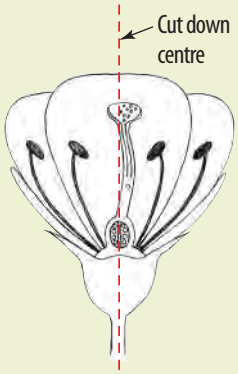
sharp knife or razor blade

cutting board

hand lens

tweezers

- Draw a picture of your flower. Locate, count and label the petals and sepals.



- Identify and label the male and female parts you can see.
- Place the flower on the cutting board and hold it with the tweezers.
- Carefully cut the flower in half down the middle (a vertical cross-section).
- Use the hand lens to look at the ovary and eggs.
- Draw the cross-section and label the female parts inside the flower.

DISCUSS AND EXPLAIN

1 Which parts of the flower become the seeds?

2 Which part of the flower do you think will grow into the fruit?

INQUIRY: INVESTIGATION 5.4

Angiosperm anatomy

KEY INQUIRY SKILLS:

- planning and conducting
- processing and analysing data and information
- evaluating

Equipment:

5 pieces of blank A4 paper

pencil

SOME WORDS OF WARNING:

1 Be responsible in your fieldwork and handle the plant parts very gently and carefully.

2 Do not pick, break, tread, trample or climb the plants.

3 Remember that you are dealing with living things.

- Find five plants, each with different types of flower.
- Using a separate page for each plant:
  - (a) at the top of the page
    - — record your name and the date
    - — record the plant's name, or, if unknown, record it as 'specimen A, B, C' etc.
    - — give a general description of the location in which the plant is found.
  - (b) divide the rest of your A4 sheet into three sections:
    - (i) half-page sketch of a flower
      - — Try to show the parts listed in the table on the opposite page and label them.
      - — Count or estimate how many stamens, stigma, petals and sepals are present.
    - (ii) quarter-page sketch of a leaf — include any veins that you see.
    - (iii) quarter-page sketch of the plant's overall appearance.
- Record the colour, scent (also give a mark out of 10 for its strength), and the texture and shape of the flowers, leaves and stems next to your diagrams.

INVESTIGATE, DISCUSS AND EXPLAIN

1 Identify key similarities and differences between the observed flowers. Suggest possible reasons for these.

2 Comment on your colour and scent data. Suggest a hypothesis to investigate a possible relationship between these.

3 Research your observed plants using databases and the internet. Construct a table, field guide, cluster map or multimedia format to summarise your findings on the following:
- (a) possible identification
- (b) labelled sketch or image of flower and fruit
- (c) type of pollination and type of seed dispersal
- (d) an interesting fact.

4 Suggest strengths, limitations and improvements for this investigation.

UNDERSTANDING AND INQUIRING

REMEMBER

1 Construct a mind or concept map to summarise the functions of different parts of a flower.

2 Draw a flowchart to show how flowering plants reproduce.

3 Which part of the plant is the fruit?

4 Match the words in the left-hand column (below) with those in the right-hand column.

sepal	sperm
petal	sugar
pollen	leaflet
nectary	colour
ovule	egg cell

5 Explain the difference between pollination and fertilisation.

6 Which part of the plant is the fruit?

THINK

7 Suggest reasons plants produce so much pollen.

8 Suggest why some orchid flowers closely resemble female wasps.

9 Use storyboards, cartoons or timelines to summarise how plants reproduce.

10 Use a bubble or mind map to show some foods that are seeds or products of seeds.

INVESTIGATE AND CREATE

11 Find and research examples of wind-pollinated and insect-pollinated plants. Construct flower hats that show what you have found out about their structures.

12 What does pollen have to do with hay fever? Make a model to show the relationship.

13 What are the conditions needed by most plants for germination?

14 Find four examples of different ways that the seeds of plants can be dispersed. Construct a story or play that includes these examples. Make puppets for the various roles in your story and present your play to the class.

15 Find out more about the life cycle of a plant of your choice. Report your findings as models, puppets or a poster.

16 Construct a Gantt chart or storyboard that includes seed dispersal, pollination, fertilisation, germination and development into a seedling.

17 Write a poem about the sex life of plants. Include as many of the bold-typed words in this section as possible.

work sheets
- 5.5 Science battles weeds
- 5.6 The sex life of plants
- 5.7 Those fabulous plants!

INVESTIGATE

18 Is there a relationship between the colour of a flower and the strength of its scent? Design and then carry out an investigation to determine whether the colour of the flower influences how strong the scent is.

19 Do some insects prefer some types of flower colour to others? Research or devise your own investigation. Share your conclusions with others in your class.

20 Complete the **Sex life of plants** interactivity in your eBookPLUS to answer questions about how plants reproduce. Success rewards you with a video of pollination. **int-0211**

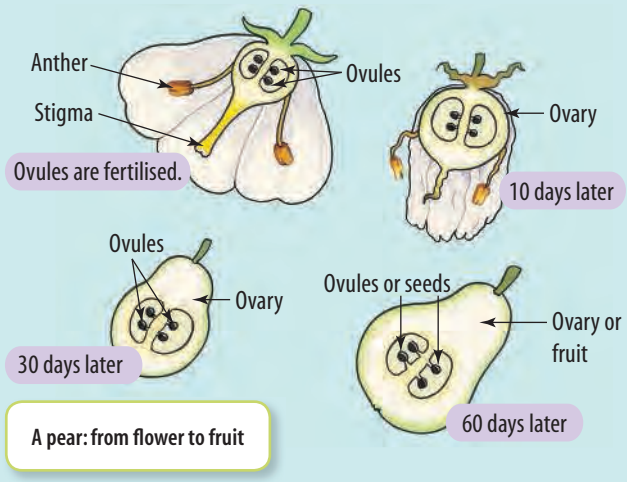
eBookplus

21 Find out more about the seed dispersal of five different types of plants and report your findings in a visual map.

22 Use information in this section and other resources to relate structural features of the following parts of the reproductive system of a flowering plant to their functions.

Part of system	Structural features	Function
Stigma		
Style		
Petal		
Ovary		
Pollen		
Pollen tube		
Seed		
Nectary		

23 The figure below shows stages in the formation of a pear (fruit) from the flower. Use the internet to find details of this process for three other fruits. Present your findings in labelled diagrams.



A pear: from flower to fruit

When one becomes two

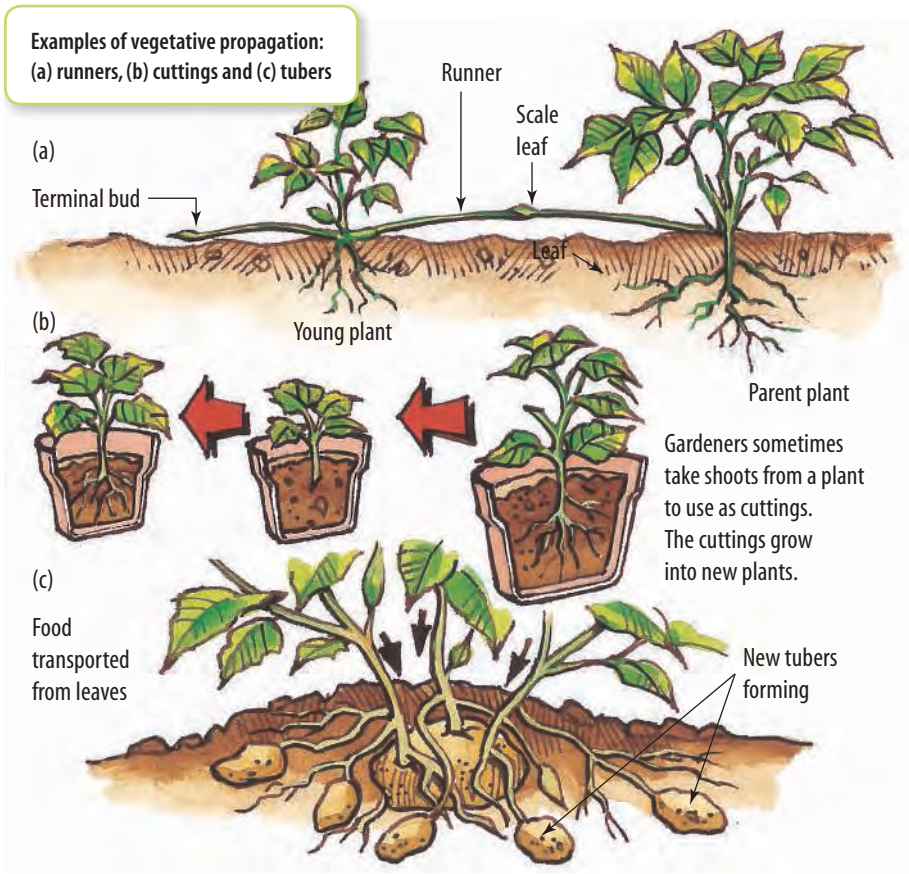
It might take two to tango, but there are times when it takes only one to multiply into many.

Not all animals reproduce themselves by sexual methods. Some can produce new individuals all by themselves. This is called **asexual reproduction**. It does not require the sex cells of another organism. Unlike the offspring resulting from sexual reproduction, all the offspring of asexual reproduction are identical to each other. These offspring are also identical to the original cell or organism from which they came. This difference between the two types of reproduction can have both advantages and disadvantages. Can you think of what these might be?

There are many different processes that involve asexual reproduction. Some examples include vegetative propagation, binary fission, budding, regeneration, parthenogenesis, and tissue and organ growth. New technologies, such as cloning, also involve the use of this type of reproduction.

Taking a short cut

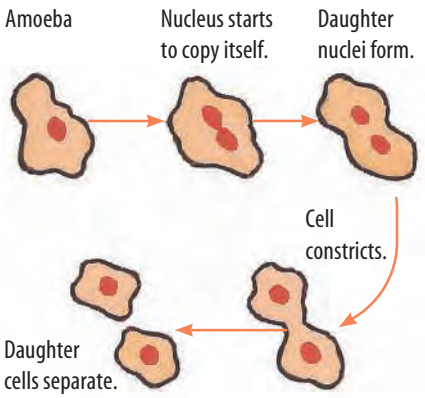
In **vegetative propagation**, the non-sexual parts of the plant are used to develop new individuals of the same type. Examples include bulbs (e.g. daffodils), stem tubers (e.g. potatoes), runners (e.g. native violets) and cuttings (e.g. roses).



Examples of vegetative propagation: (a) runners, (b) cuttings and (c) tubers

Let's split

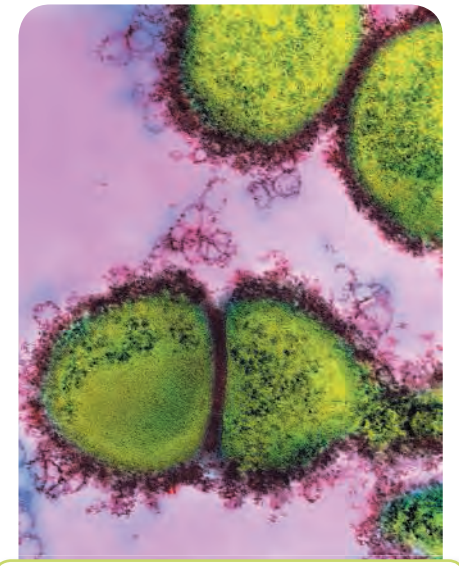
Some bacteria and other single-celled organisms such as amoebae reproduce by a type of asexual reproduction called **binary fission**. One parent divides into two new organisms, which each divides into two new organisms. Other bacteria may produce offspring by multiple fission, in which more than two daughter cells are produced with each division. This form of reproduction is very efficient, as it allows a rapid increase in numbers.



When one becomes two: binary fission in an amoeba

HOW ABOUT THAT!

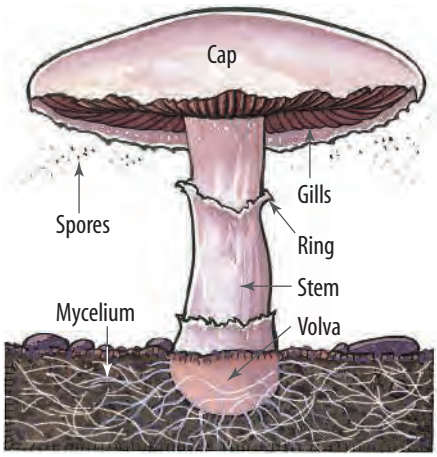
Flatworms and starfish have an unusual habit for animals in that they can reproduce asexually by regeneration. If the parent breaks into two or more pieces, each of these pieces may grow into a new organism that is a copy of the parent.



***Streptococcus pyogenes* bacteria, carried harmlessly by many people in their nose or throat. The bacterium at lower centre is dividing into two cells by binary fission.**

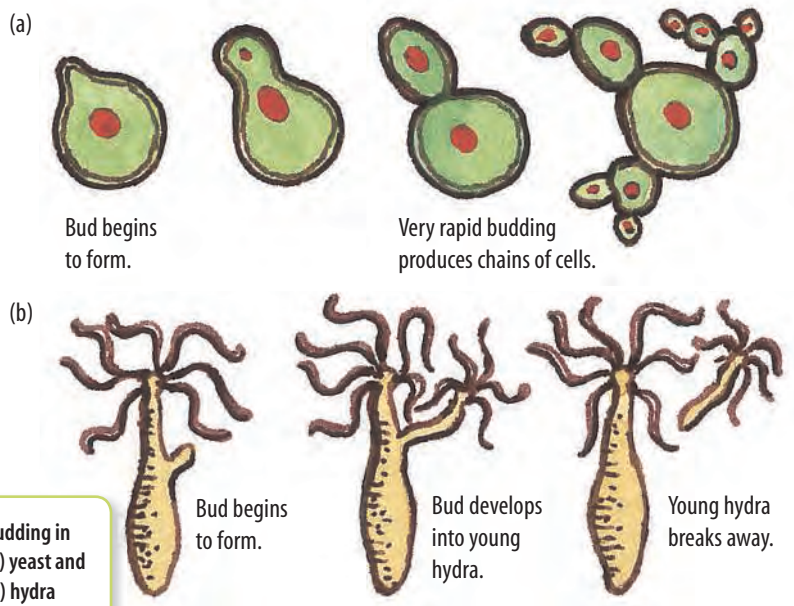
Spores on the wind

Some fungi (such as mushrooms, and bread and fruit mould) have spores that, when released, may develop into offspring identical to the parent fungi. These spores are merely a group of unspecialised body cells, combined with a source of nutrients and packaged in a resistant coat. They can provide an effective means of dispersing future generations and may also overcome adverse conditions by waiting until conditions are favourable before they begin to grow.



Budding offspring!

Imagine your offspring beginning as a simple swelling on your side and then developing its own mouth and features. When its development is complete it merely detaches itself and independently continues its own life. This is the sequence of events that happens in yeasts, and also in freshwater hydra. The initial swelling is called a bud and hence this process is often called **budding**.



Budding in (a) yeast and (b) hydra

Tiny new jellyfish (medusae) that have formed by budding

Girls only?

In some animals, the females produce eggs, but these develop into embryos without fertilisation taking place. The scientific name for the development of new individuals from an unfertilised egg is **parthenogenesis**. Worker bees, for example, develop from unfertilised eggs laid by the queen bee.

Some gecko lizard groups are parthenogenetic and form all-female families. An example is Bynoe's gecko (*Heteronotia binoei*), which is found only in Australia. A population of these geckos would contain only females. Births that result without any meeting between eggs and sperm are often referred to as **virgin births**.

INQUIRY: INVESTIGATION 5.5

Asexual reproduction

KEY INQUIRY SKILLS:

- planning and conducting
- processing and analysing data and information

Equipment:

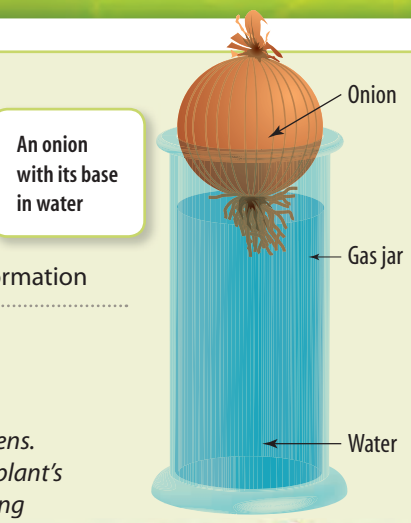
large onion *potato*

grass runner

leaf–stem cutting from geranium or impatiens. Note: a leaf–stem cutting is a piece of the plant's stem that is cut just below a joint or growing point and has a least three leaves.

leaf from an African violet, jade plant or snake plant

rooting medium (this can be purchased from a nursery)



An onion with its base in water

A leaf–stem cutting

- Fill a gas jar almost to the top with water and place the onion in the mouth of the gas jar so that its base is sitting in the water as shown in the diagram.
- Leave the potato in a dark cupboard.
- Remove the lower leaves from the leaf–stem cutting. Quarter fill a beaker or glass jar with water and place the cutting in the water.
- Place some rooting medium in a pot. Add water to the rooting medium until it feels moist. Cut a 3 cm section from the leaf of the African violet, jade or snake plant. Stand the piece of leaf upright in the rooting medium.
- Cut a piece of the grass runner. Ensure the section you have cut has at least one growing point. Press the piece of grass runner into the rooting medium (laying it flat on the surface).
- Leave all the plant parts undisturbed for two weeks. You may need to top up the water over that time.

DISCUSS AND EXPLAIN

1 Copy and complete the table below. You may need to dig the leaf–stem cutting and the runner from the rooting medium and wash them to see what has happened to them.

Plant part	Description after two weeks	Diagram
Onion		
Potato		
Leaf–stem cutting		
Leaf		
Runner		

2 Explain why each of the examples in the table above are forms of asexual reproduction.

3 What are the advantages of growing plants using one of the techniques described above rather than growing them from seeds?

4 Suggest improvements to the design of the investigation.

UNDERSTANDING AND INQUIRING

REMEMBER

1 What is asexual reproduction?

2 Describe the differences between the following types of asexual reproduction: budding, fission, cuttings, regeneration.

3 (a) What is parthenogenesis?

(b) Does this process involve sexual or asexual reproduction?

THINK AND DISCUSS

4 Suggest a reason why the parent involved in parthenogenesis is female.

5 Make a list of the advantages and disadvantages of parthenogenesis.

6 Suggest why many insects, which would usually reproduce sexually, use parthenogenesis to produce offspring in favourable conditions.

INVESTIGATE

7 (a) Place a carrot top on moist cotton wool until leaves appear, then transfer the plant to a plastic pot containing moist potting mix. Record what happens.

(b) Try this with a variety of other vegetables. Summarise your findings.

8 Find out more about parthenogenesis and virgin births.

9 Investigate and report on the impact of plant cloning techniques in agriculture in one of the following areas: horticulture, fruit production, vineyards.

10 Investigate the use of cloning technology in Australia. Organise a debate on any relevant issues.

Storyboards and Gantt charts

1. Decide how many scenes you need in your story. Often, 6–8 is a good number. Divide your page into this number of equal sections.
2. Consider which will be the three main events in your story and draw them roughly in the first, middle and last sections of your page.
3. Brainstorm the scenes that fit between these. Select the most appropriate and add them as intermediate scenes.
4. Mentally stand back and examine your story outline; make any desired changes to enhance its dramatic impact.

how to ...?

Helps you to use both your imagination and organisational skills to capture and share thoughts and ideas

why use?

What are the main scenes in a story or event?

question

Storyboard

A	B	C
Outline of scene 1	Outline of scene 2	Outline of scene 3
D	**E**	**F**
Outline of scene 4	Outline of scene 5	Outline of scene 6

also called

Comic strip

comparison

Similarity

Both show the sequence of events.

Difference

Storyboards use sketches or diagrams while Gantt charts use tables.

Gantt chart

example

Action	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1							
2							
3							
4							
5							
6							
7							
8							

UNDERSTANDING AND INQUIRING

THINK AND CREATE

1 Construct storyboards for the following:
   (a) how you have changed between birth and ages two, four, six, eight and ten, and your current age
   (b) the 'life of a sperm' or the 'life of an egg'
   (c) how you could tell a Year 3 primary student 'the facts of life'.

2 (a) Read through the information in the 'Week by week' article below.
   (b) Mind map what you consider to be the key points.
   (c) Construct storyboards to show:
      (i) the changes experienced by the mother
      (ii) the baby's development.
   (d) Construct a Gantt chart to sequence your key points.

A baby's arms and legs start to form very early on. Soon, her limbs will lengthen, fingers and toes will develop and she'll be able to move them.

WEEK BY WEEK

Week 0–3
You … Seven days after implantation, chemical signals are sent to stop your period.

And your baby … Your fertilised egg moves down the fallopian tube. By day seven, it has implanted in the uterus wall.

Week 4
You … A pregnancy test will be able to detect that you are pregnant about 12 days after fertilisation.

And your baby … By the time she's reached 14 days after fertilisation, your baby has developed into an individual (twins can develop up until week four).

Week 5
You … may notice some signs that you are pregnant, such as changes to your sense of smell.

And your baby … is gently floating in the amniotic fluid attached to you only by the umbilical cord. She measures around 7 mm — about the length of a grain of rice.

Week 6
You … may feel the first symptoms of morning sickness, caused by the amount of pregnancy hormones in your body.

And your baby … Her heart forms a tube measuring half a centimetre — and already it can drive blood around her body.

Week 7
You … may feel completely exhausted because of all the hormonal changes in your body. You might go off tea and coffee altogether.

And your baby … Her head and tail have formed, as have tiny rudiments of eyes, kidneys and lungs. She's about the size of a five cent piece.

Week 8
You … Your uterus is now the size of an orange.

And your baby … The outline of your baby's face now appears — the two halves of her face will come together and meet in the middle. She's also been growing rapidly and now measures around 2.5 cm.

Week 9
You … probably won't look different to other people but you may notice your breasts are getting bigger and your waist is starting to thicken.

And your baby … has toes! Her liver is producing red blood cells which are pumped around her body by her tiny heart.

Week 10
You … are a quarter of the way through pregnancy and the time when you are most at risk of having a miscarriage is coming to a close.

And your baby … Her face is recognisably human and external sex organs have begun to form. She measures 6 cm.

Week 11
You … may have gained 900 g–1.3 kg (which is about 10 per cent of your total weight gain).

And your baby … is 7 cm and would fit into your palm. All her major body organs have formed and the most critical period in her development has passed.

Week 12
You … Your uterus is too large to remain in your pelvis and pushes above your pelvic bone. You'll feel hotter because extra blood is circulating in you.

And your baby … weighs about 14 g and is around 8 cm long. You can see her arm and leg movements on scans.

Source: Australian Pregnancy and Birth, September/October 2004

STUDY CHECKLIST

ASEXUAL REPRODUCTION

- contrast sexual and asexual reproduction
- outline the role of cell division in asexual reproduction
- describe some types of asexual reproduction

SEXUAL REPRODUCTION

- describe fertilisation
- contrast internal and external fertilisation
- outline the life cycle of flowering plants
- compare the reproductive systems of three different animals
- contrast mammalian and plant sexual reproduction

HUMAN REPRODUCTION

- recall the name and function of the organs of the male and female human reproductive system
- relate the structure of the organs of the male and female reproductive system to their function
- explain the role of the placenta
- outline the role of hormones in reproduction
- outline some technological advances that have been used in the fight against cervical cancer
- describe the process of fertilisation
- outline some changes that occur to the zygote between the time of fertilisation and implantation
- outline some changes that occur to a fetus as it develops inside the womb
- describe the birth process in humans
- describe some birth control techniques

LIFE CYCLE OF FLOWERING PLANTS

- recall the names and functions of the parts of flowering plants
- distinguish between pollination and fertilisation in flowering plants
- describe how fruit and seeds are formed from flowers
- outline ways in which seeds can be dispersed

REPRODUCTIVE TECHNOLOGIES

- evaluate the benefits and disadvantages of a number of reproductive technologies
- identify some causes of infertility
- assess the impact of reproductive technologies
- describe fertility treatments including artificial insemination and in-vitro fertilisation

INDIVIDUAL PATHWAYS

eBookplus

Activity 5.1
Growth and reproduction
doc-6087

Activity 5.2
Investigating growth and reproduction
doc-6088

Activity 5.3
Analysing growth and reproduction
doc-6089

ICT

eBookplus Summary

eLESSONS

Methods of contraception
This eLesson will help you understand the many different forms of contraception and how effective they are in preventing conception.

Searchlight ID: eles-0127

Growing plants in Australia
This video lesson is presented by a top Australian horticulturalist and provides you with tips for successfully growing plants in Australia. Watch this video as an introduction to your experiments with plants.

Searchlight ID: eles-0055

INTERACTIVITIES

Know your privates
In this interactivity, your knowledge of the male and female reproductive organs is tested by challenging you to identify private parts from the clues provided.

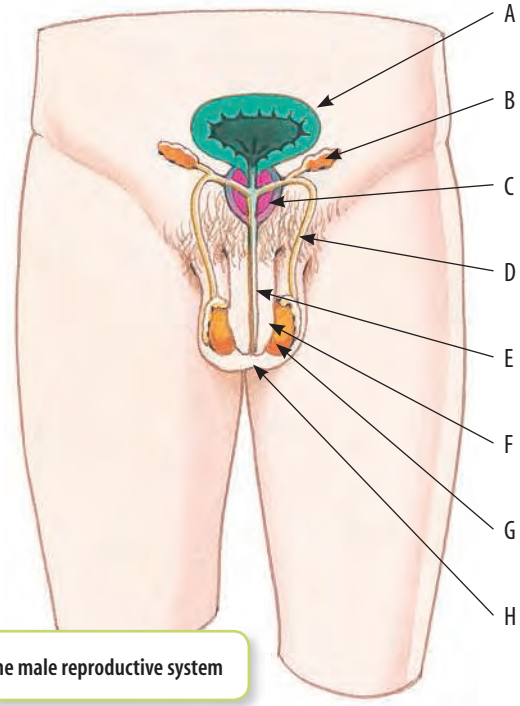
Searchlight ID: int-0671

Sex life of plants
This interactivity delves into the seedy world of the sex life of plants. Play the revelation game and answer questions about how plants reproduce. Success rewards you with an animation of the sex life of plants.

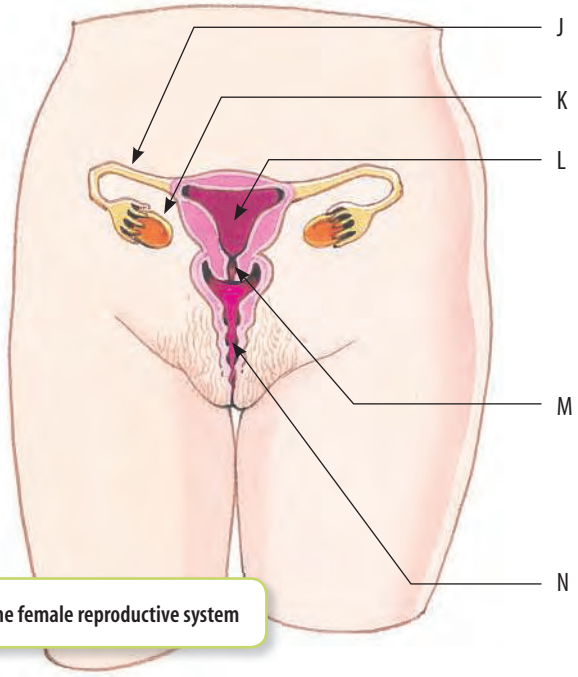
Searchlight ID: int-0211

LOOKING BACK

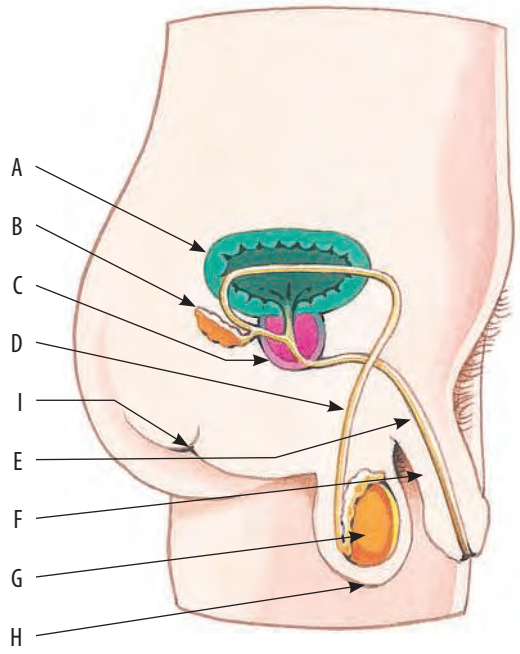
1 Identify the parts labelled A–T in the diagrams below. Write one function of at least two parts in each diagram.

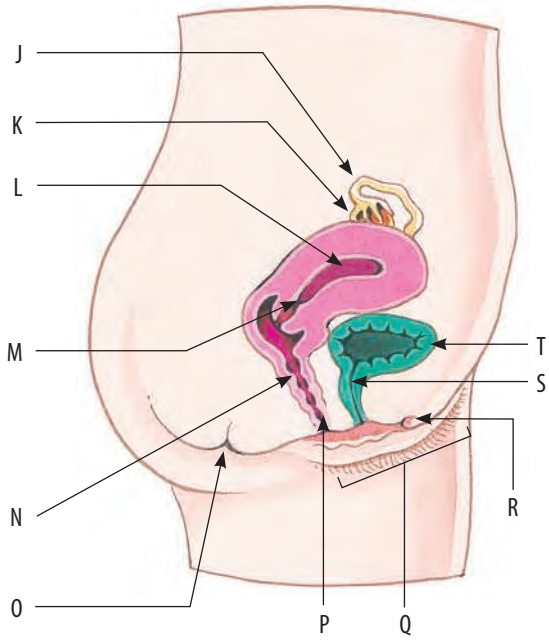


The male reproductive system



The female reproductive system





2 Design a calendar of the menstrual cycle and then outline the events that occur at each stage on your calendar.

3 Unscramble the following types of asexual reproduction.

taevvegeti gatponproai — gatienreoner
narybi sfionis — sheneipartognes

4 Summarise the disadvantages and advantages of sexual and asexual reproduction.

5 Invent, design and make your own creature. Describe its courting and mating behaviour, and give details about the way it reproduces.

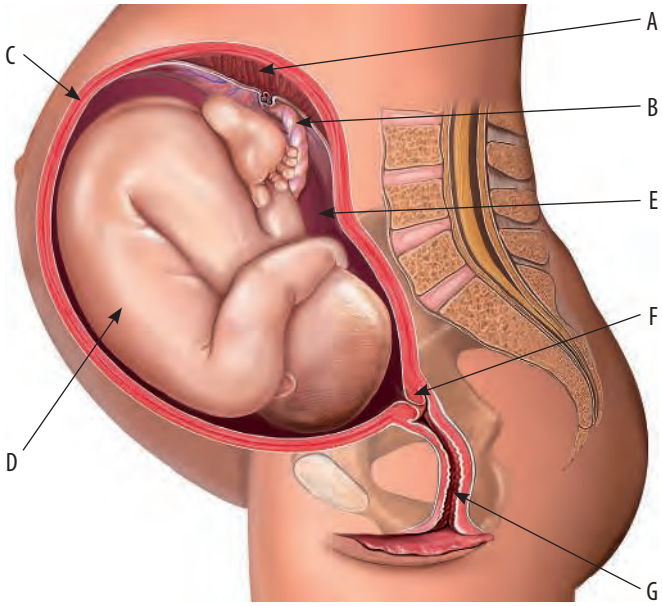
6 A paramecium is a single-celled organism that reproduces asexually.

(a) Make a list of the advantages and disadvantages of reproducing this way.
(b) Compare your list with that of your team. Discuss any differences.
(c) Find out more about paramecia and, as a team, write and perform a paramecium puppet play about their lives.

7 Match the contraceptives below with the way they prevent conception and their effectiveness.

Contraceptive	How it prevents conception	Effectiveness
Condom with spermicide	Prevents ova from developing	Extremely effective
Diaphragm without spermicide	The fallopian tubes or vas deferens are cut and sealed	Unreliable
Daily contraceptive pill	Keeps sperm and semen from entering the woman's vagina after ejaculation	Highly effective
Surgical: vasectomy and tubal ligation	Removal of male's penis from the vagina before ejaculation	Highly effective
Coitus interruptus	Prevents sperm cells from reaching the cervix	Moderately effective

8 Label the parts A–G in the diagram below:



9 (a) Using information from this chapter, make at least 20 'reproduction game cards' with a question on one side and the answer on the other side.
(b) Write a list of any questions that you still have about reproduction.
(c) Research at least three of these questions and summarise your findings on 'reproduction game cards' with the question on one side and the answer on the other.
(d) Design and construct a game board with at least one diagram idea from this chapter.
(e) Design a game that uses the cards and the board that you have made. Create a game rules book so that others will know how to play it. Create any other materials that you need for your game.
(f) Play each other's games.

10 Construct a working model that simulates some aspect of this chapter.

11 It has been said that we are currently in the midst of a biotechnological revolution with new technologies offering us many more reproductive options. Is this true for all parts of the world? Hold a discussion about the global impact of reproductive technologies.

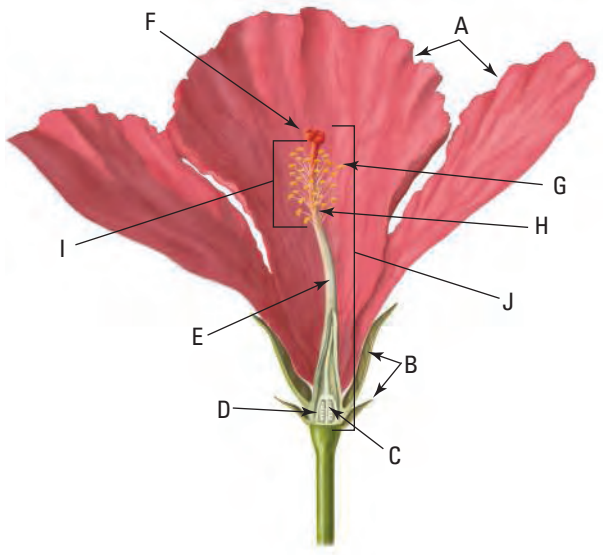
12 Construct a table naming the organs of the human male and female reproductive systems. For each organ, describe its structure and function.

13 Suggest how scientific knowledge about the life cycles of plants and animals can be used to develop regulations about importation of foodstuffs into Australia. Suggest reasons for these regulations.

14 Suggest how knowledge of the life cycle of a particular plant or animal may influence the practices of an agriculturalist.

15 On the basis of what you have learned in this section of your studies, suggest responses to the following questions:
(a) How can there be weeds in the garden if I didn't plant them there?
(b) Why don't twins always look the same?
(c) Why doesn't my caged bird lay eggs that can hatch into baby birds?

16 Write down in your workbook which letter in the following diagram corresponds to each of these terms.
ovules, sepals, filament, style, stigma, ovary, anther, petals, stamen, carpel



Heights (cm) of seedlings

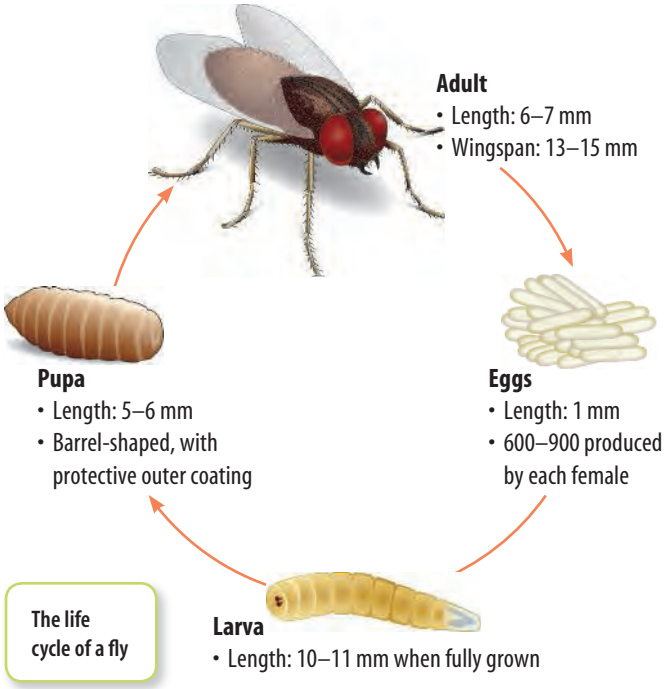
Position	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Fridge	5.0	5.5	6.0	6.2	6.6	7.0	7.3	7.5	7.7	8.0
Garage	5.0	5.6	6.2	6.6	7.0	7.3	7.6	7.9	8.4	8.8
Windowsill	5.0	6.0	6.7	7.5	8.0	8.5	9.0	9.6	10.2	10.6
Desk	5.0	5.8	6.3	7.0	7.5	8.0	8.5	9.1	9.6	10.0

17 Charlotte wanted to find out if temperature affects the growth of plants. She bought four seedlings. She put one seedling in the fridge and one in her garage (which has no windows so is dark and cooler than her house). She put the third seedling on the windowsill (in full sun) and the fourth seedling on her desk (out of the sun but in daylight). Charlotte measured the height of each seedling every day for 10 days. Her results are shown in the table above.
(a) Write an aim for Charlotte's experiment.
(b) Suggest three improvements to Charlotte's experiment.
(c) Graph Charlotte's results.
(d) Write a conclusion for this experiment.

Complete the following activities to produce a learning and thinking journal for this chapter.

18 Draw a diagram of an insect-pollinated flower and use descriptive labels to show what each part does.

19 (a) Use a table to show differences between the sizes, shapes and structures of a fly during each stage of its life cycle.
(b) Construct a graph to show the differences in length during the adult, egg, larval and pupal stages of the life cycle.
(c) Suggest possible survival advantages for the differences throughout the life cycle.

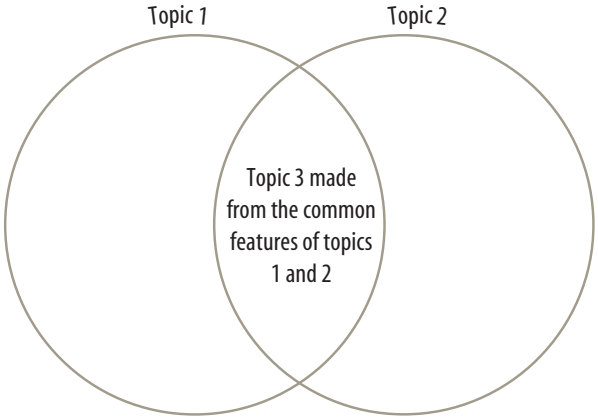


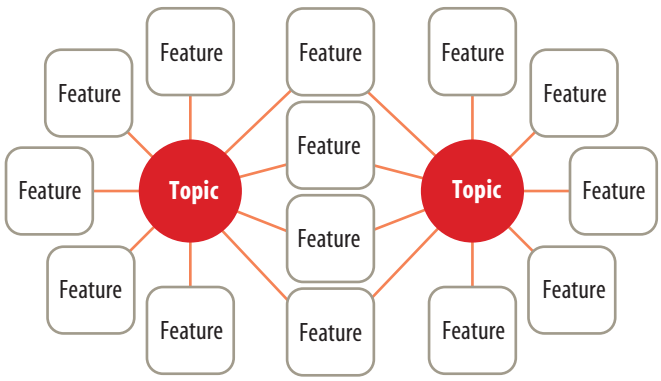
The life cycle of a fly

20 Use a matrix to compare flowers that are wind pollinated with those that are insect pollinated.

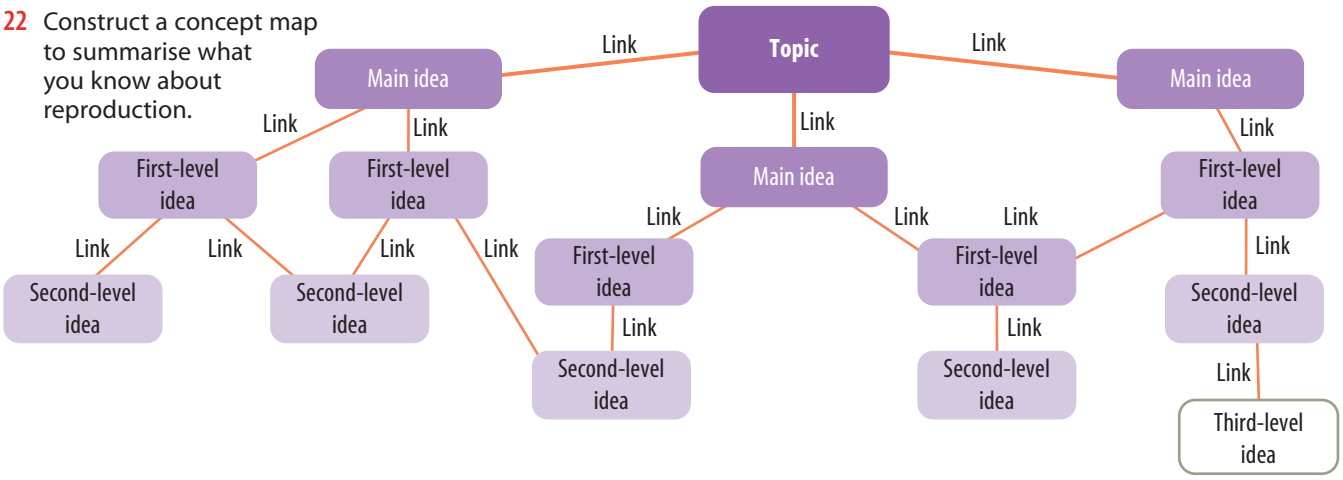
Topic	Feature A	Feature B	Feature C	Feature D	Feature E
1	✓		✓	✓	✓
2		✓			✓
3		✓		✓	✓
4			✓	✓	✓

21 Construct a Venn diagram or double bubble map to show the similarities and differences between:
(a) structures involved in plant and animal reproduction
(b) fertilisation in plant and animal reproduction
(c) fusion of gametes in plants and animal reproduction
(d) embryo development in plants and animals
(e) 'birth' in plants and animals.



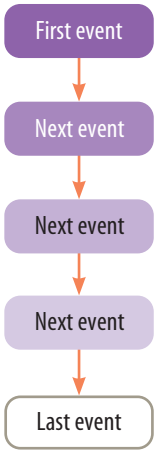


22 Construct a concept map to summarise what you know about reproduction.

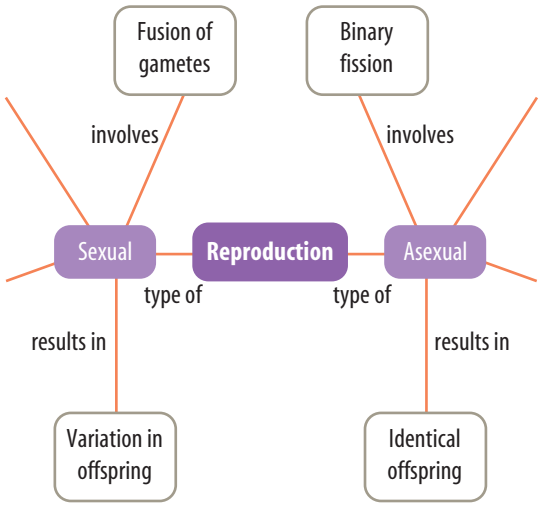


23 Increased knowledge and understanding of reproductive processes have led to the development of new reproductive technologies. Construct a PMI for issues associated with one of these technologies.

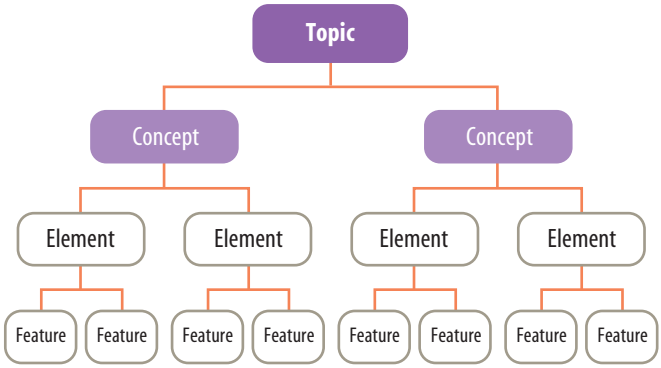
24 Use a flowchart to show an example of a life cycle of a flowering plant. Include pollination, fertilisation, development, seed dispersal and germination.



25 Use the figure below to help you construct a summary of the differences between sexual and asexual reproduction. What other features can you add?

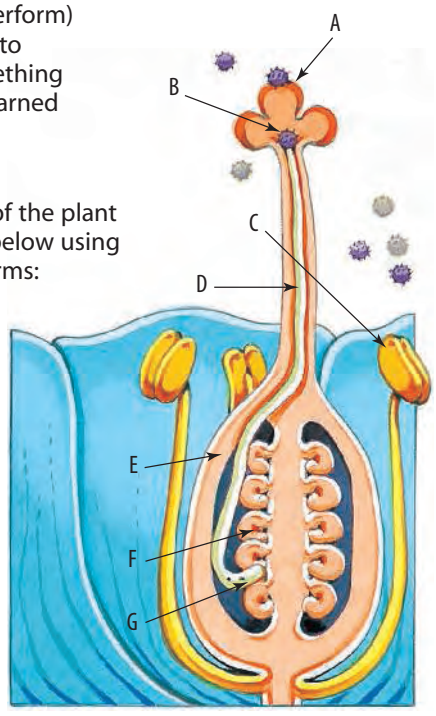


26 Use a tree map to show two sides of a discussion about plant reproduction and animal reproduction.



27 Make up (and perform) a song or poem to summarise something that you have learned in this chapter.

28 Label the parts of the plant in the diagram below using the following terms:
stigma,
male gamete,
pollen grain,
pollen tube,
stamen,
ovary,
ovule.



work sheets
5.8 Science literacy 1
5.9 Science literacy 2
5.10 Reproduction: Crossword