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BIOLOGI
TINGKATAN 5
CIKGU ASHRAAF

BIOLOGI TINGKATAN 5			
BAB	**TOPIK**	**TARIKH**	**CATATAN**
1	ORGANISASI TISU TUMBUHAN DAN PERTUMBUHAN / *ORGANISATION OF PLANT TISSUES AND GROWTH*		
2	STRUKTUR DAN FUNGSI DAUN / *LEAF STRUCTURE AND FUCTION*		
3	NUTRISI DALAM TUMBUHAN / *NUTRITION IN PLANTS*		
4	PENGANGKUTAN DALAM TUMBUHAN / *TRANSPORT IN PLANTS*		
5	GERAK BALAS DALAM TUMBUHAN / *RESPONSE IN PLANTS*		
6	PEMBIAKAN SEKS DALAM TUMBUHAN BERBUNGA / *SEXUAL REPRODUCTION IN FLOWERING PLANTS*		
7	PENYESUAIAN TUMBUHAN PADA HABITAT / *ADAPTATIONS OF PLANTS IN DIFFERENT HABITATS*		
8	BIODIVERSITI / *BIODIVERSITY*		
9	EKOSISTEM / *ECOSYSTEM*		
10	KELESTARIAN ALAM SEKITAR / *ENVIRONMENTAL SUSTAINABILITY*		
11	PEWARISAN / *INHERITANCE*		
12	VARIASI / *VARIATION*		
13	TEKNOLOGI GENETIK / *GENETIC TECHNOLOGY*		

CHAPTER

15 Sexual Reproduction, Development and Growth in Humans and Animals

How does modern technology help in conception?

Do You KNOW...

- What are the features of the anatomical system of human reproduction?
- How is gamete formed?
- How does the period cycle happen?
- How does the development of the human foetus happen?

15.1 Reproductive System of Humans

15.1.1 Characterise the anatomy of the:
- male reproductive system
- female reproductive system

15.2 Gametogenesis in Humans

15.2.1 Justify the necessity of gametogenesis.

15.2.2 Describe gamete formation:
- spermatogenesis
- oogenesis

15.2.3 Identify the structure of:
- sperm
  - head
  - middle piece
  - tail
- Graafian follicle
  - secondary oocyte
  - follicular cells

15.2.4 Compare and contrast between spermatogenesis and oogenesis.

15.3 Menstrual Cycle

15.3.1 Analyse the changes in the levels of hormones involved during:
- menstruation
- follicle development
- thickening of the endometrium
- ovulation
- corpus luteum formation

15.3.2 Correlate the changes in the levels of hormones involved with:
- pregnancy
- miscarriage

15.3.3 State the meaning of premenstrual syndrome and menopausal syndrome

15.4 Development of a Human Foetus

15.4.1 Describe the fertilisation process and the formation of zygotes.

15.4.2 Make a sequence and explain the early development of an embryo until implantation:
- two-celled embryo
- morula
- blastocyst

15.4.3 Explain the role of human chorionic gonadotropin (HCG) hormone in the early stages of pregnancy.

15.4.4 Communicate about the roles of following structures in the development of a foetus:
- placenta
- umbilical cord

15.4.5 Justify the necessity for separate foetal and maternal blood circulatory systems.

15.5 Formation of Twins

15.5.1 Describe the processes in the formation of twins:
- identical twins
- fraternal twins

15.5.2 Compare and contrast identical and fraternal twins.

15.5.3 Correlate cellular division with the formation of conjoined twins.

15.6 Health Issues Related to the Human Reproductive System

15.6.1 State the meaning of impotency.

15.6.2 Communicate about causes of human impotency.

15.7 Growth in Humans and Animals

15.7.1 Explain the meaning of growth in organisms.

15.7.2 Determine parameters to measure growth in humans and animals.

15.7.3 Describe the growth of insects with exoskeleton:
- complete metamorphosis
- incomplete metamorphosis

15.7.4 Analyse the growth phases on sigmoid growth curves of humans and animals.

15.7.5 Analyse the intermittent growth curve of animals with exoskeletons.

15.1 Reproductive System of Humans

The male and female reproductive system

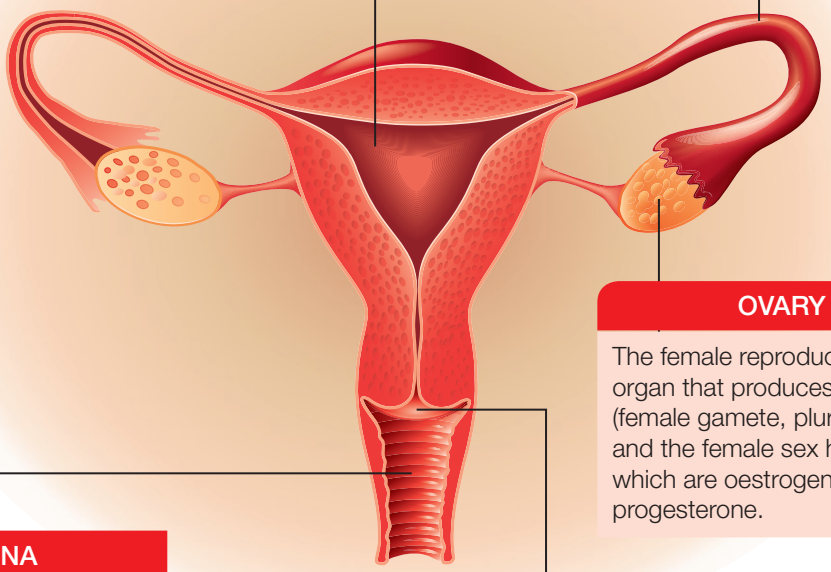
The continuity of a species is dependent on the increase in population through the process of sexual or asexual reproduction. Sexual reproduction involves the production of male and female gametes by individuals who have reached sexual maturity. This process is completed with the fertilisation of both gametes to create new life. The structure and function of the male and female reproductive systems are shown in Figure 15.1 and Figure 15.2 respectively.

UTERUS

- The uterus is an organ with thick muscular walls.
- The inner wall of the uterus is lined with endometrium tissue, which secretes mucus and is rich in blood vessels.
- Embryo implants in the endometrium.
- The endometrial tissue which is thick and rich in blood vessels supplies the embryo with nutrients and oxygen.

FALLOPIAN TUBE

- A thin, muscular tube.
- The inner wall is lined with cilia.
- The action of the cilium, combined with the peristalsis of the Fallopian tube, helps in delivering the secondary oocyte or embryo to the uterus.



OVARY

The female reproductive organ that produces ovum (female gamete, plural: ova) and the female sex hormones, which are oestrogen and progesterone.

VAGINA

A canal where sperms enter, and also serves as a passage for birth and menstruation.

CERVIX

Narrow opening to the uterus which secretes mucus to help sperm swim up to the Fallopian tubes.

FIGURE 15.1 Female reproductive system

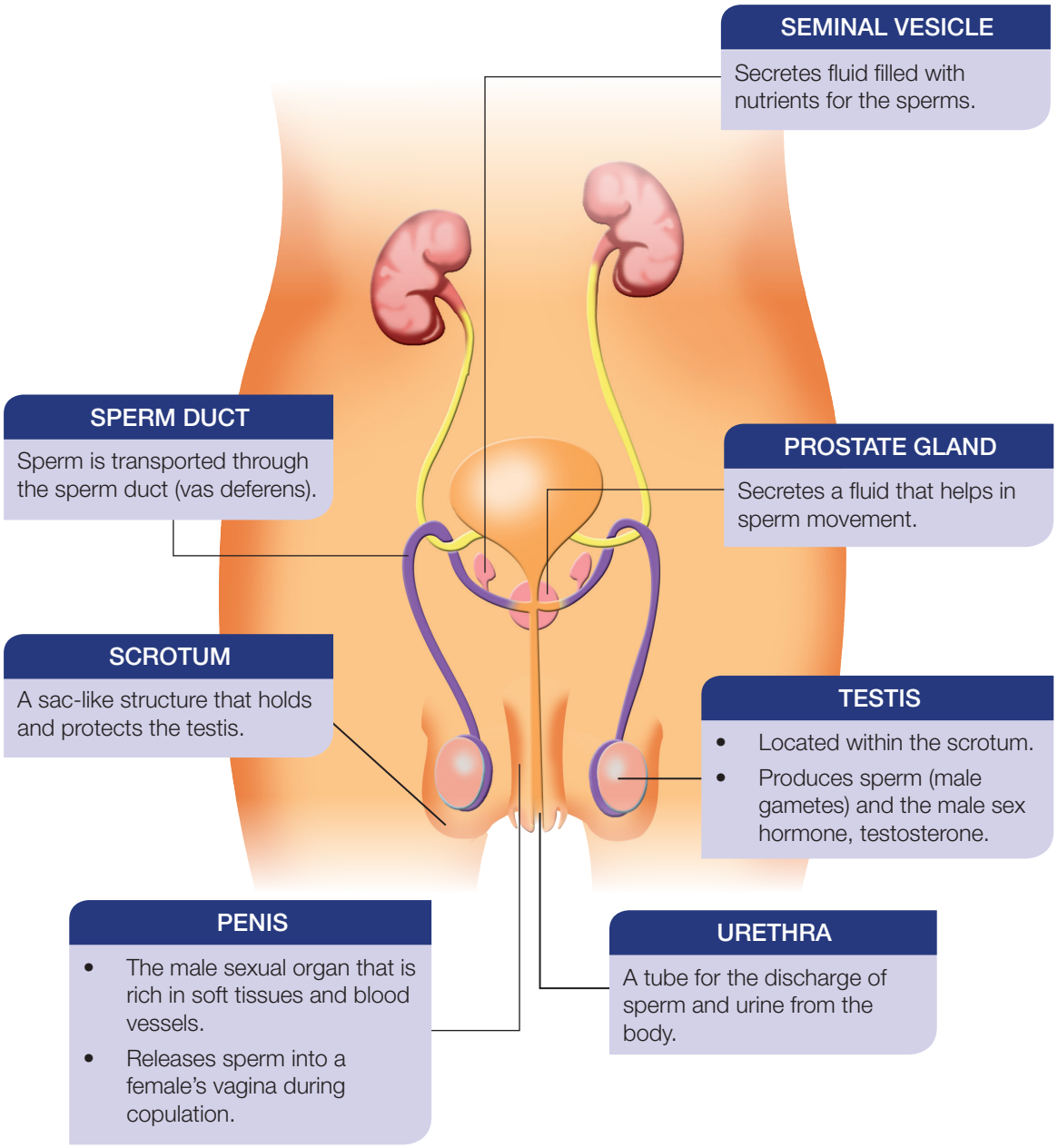


FIGURE 15.2 Male reproductive system

Formative Practice 15.1

1 State the structures of the male reproductive system.

2 Explain the functions of the seminal vesicle and the scrotum.

3 State the structures of the female reproductive system.

4 Explain the functions of the Fallopian tube and uterus.

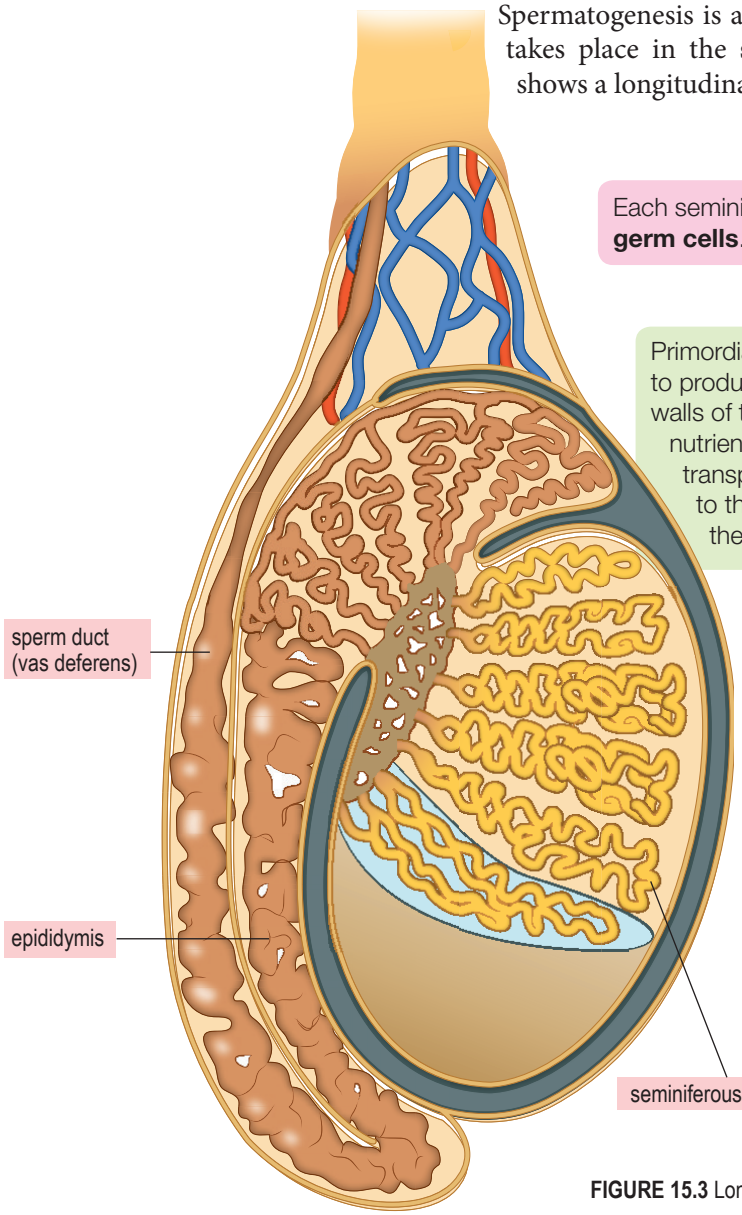
15.2 Gametogenesis in Humans

The necessity of gametogenesis

The production process of reproductive cells (gametes) is called **gametogenesis.** This process takes place in the **gonads**, which are the testes in males, and the ovaries in females. Gametogenesis produces gametes that are haploid (n). When fertilisation takes place, the nucleus of the sperm will fuse with the nucleus of the ovum in the Fallopian tube to form a diploid zygote (2n).

Spermatogenesis

Spermatogenesis is a process of **sperm production** that takes place in the **seminiferous tubules**. Figure 15.3 shows a longitudinal section of the testes.



Each seminiferous tubule consists of **primordial germ cells**.

Primordial germ cells will undergo cell division to produce sperm. **Sertoli cells** within the walls of the seminiferous tubules provide nutrients throughout this process. Sperm is transported from the seminiferous tubules to the **epididymis** and flows out through the **sperm duct (vas deferens)**.

Spermatogenesis is stimulated by the **follicle-stimulating hormone (FSH)** and **testosterone**. This process is also aided by the **luteinizing hormone (LH)** which stimulates testosterone secretion in the testes.

Figure 15.4 summarises the spermatogenesis scheme.

FIGURE 15.3 Longitudinal section of the testes

15.2.1 15.2.2

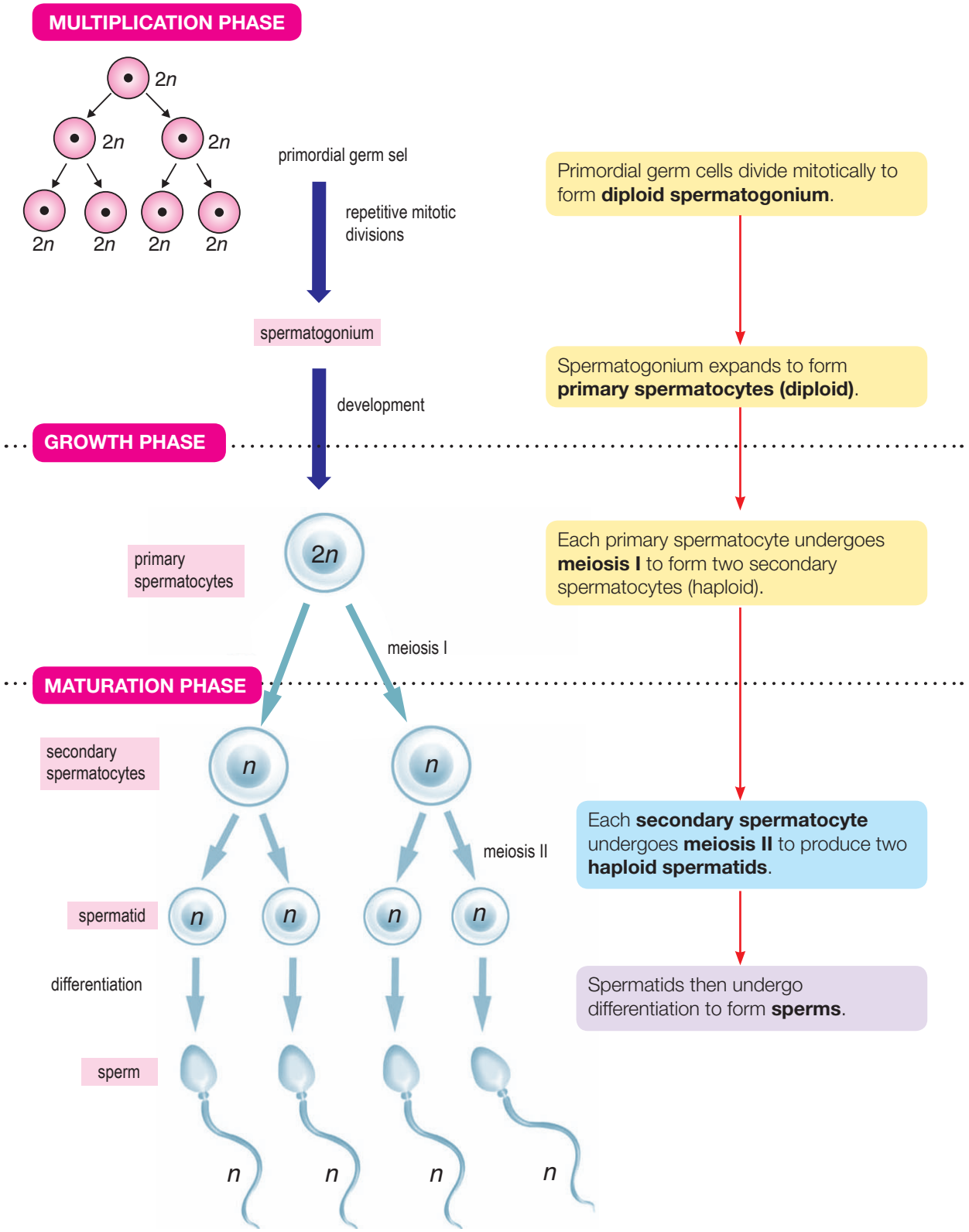


FIGURE 15.4 Spermatogenesis

15.2.2

Oogenesis

Oogenesis is the process of secondary oocyte or female gamete production (Figure 15.5). This process takes place in the ovaries. Unlike spermatogenesis, oogenesis begins in a female's ovaries before they are born.

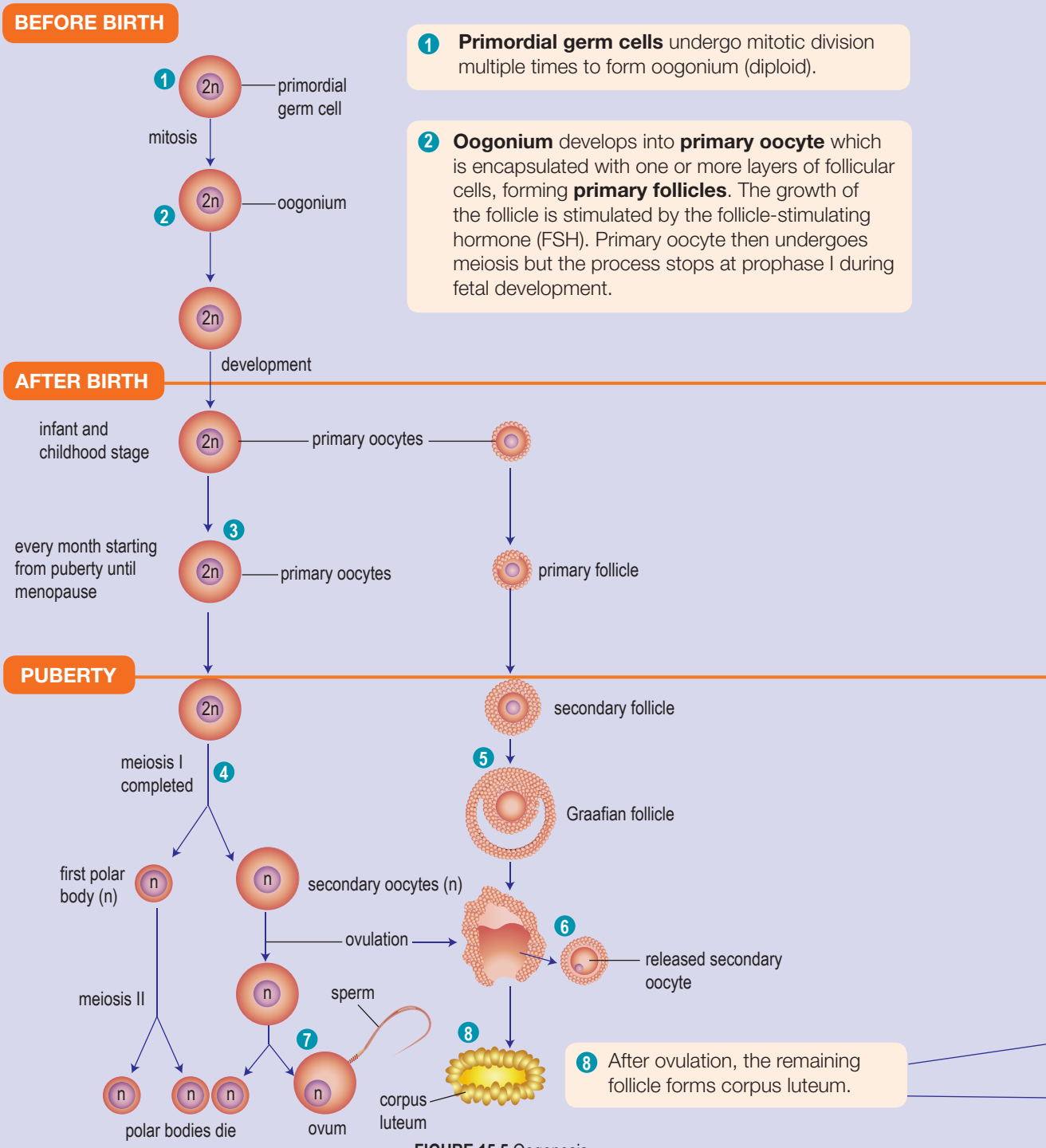


FIGURE 15.5 Oogenesis

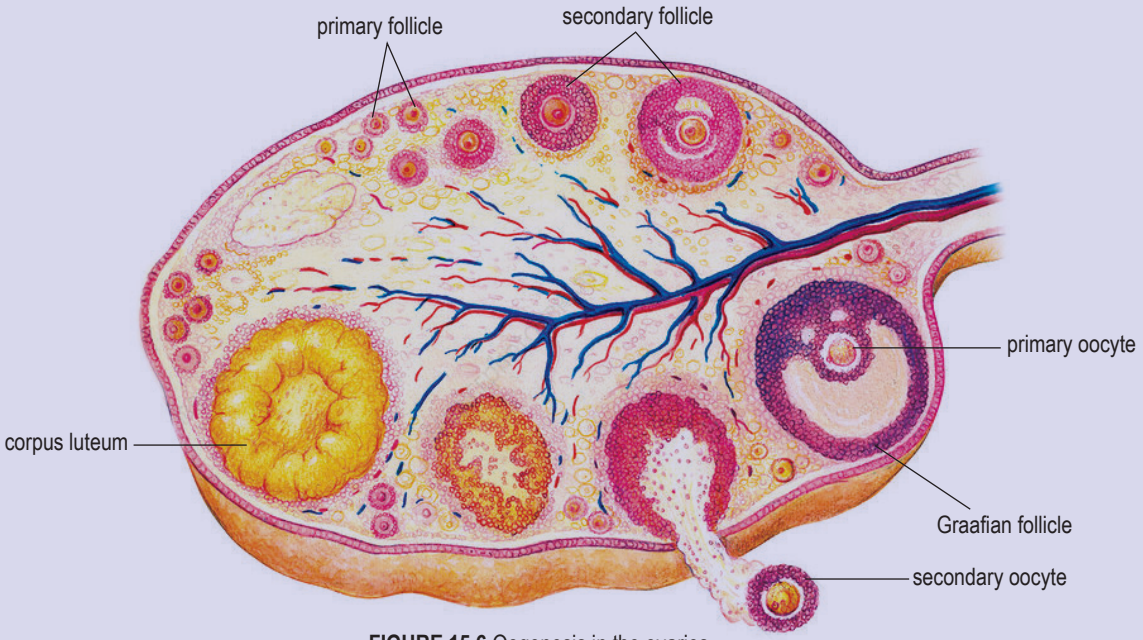


FIGURE 15.6 Oogenesis in the ovaries

3. At birth, a baby girl already has millions of primary oocytes that remain dormant in prophase I meiosis I. The number of oocytes will decrease at puberty.

4. Upon reaching puberty, the primary oocytes will continue meiosis I to form **secondary oocyte** and a **first polar body**. Secondary oocyte will begin meiosis II which is then halted at metaphase II. The first polar body will complete meiosis II and form two **second polar bodies**.

5. A layer of follicular cells envelops the secondary oocyte and is called **secondary follicle**. The secondary follicle will then develop into the **Graafian follicle**, which releases oestrogen.

6. A mature Graafian follicle will approach the surface of the ovary and release a secondary oocyte into the Fallopian tube. This process is called **ovulation**.

7. The secondary oocyte (immature ovum) will complete meiosis II once a sperm penetrates it. Meiosis II produces **ovum** (n) and **first polar body** (n). Fertilisation takes place when the sperm nucleus fuses with ovum nucleus and produces a diploid zygote (2n). The rest of the polar bodies will die and will be disintegrated by the ovary.

upon fertilisation

9. Corpus luteum continues to grow and secretes oestrogen and progesterone.

without fertilisation

10. Corpus luteum and secondary oocyte degenerate and dies, and then is removed through menstruation.

Structure of sperm and Graafian follicle

A sperm has three main parts: **head**, **midpiece** and **tail**. The head contains a nucleus whereas the midpiece is packed with mitochondria which generates energy for the sperm to swim to the Fallopian tube for fertilisation.

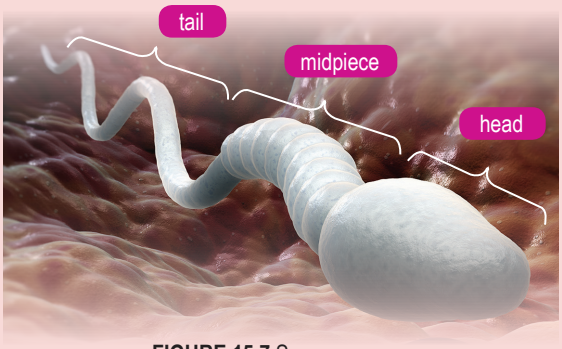


FIGURE 15.7 Sperm

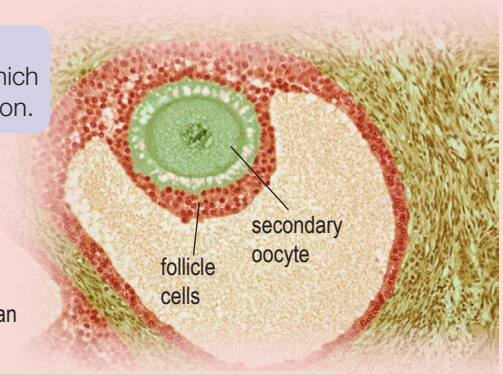


FIGURE 15.8 Graafian follicle

A **secondary oocyte** is a large cell that is surrounded by a gel-like substance and follicular cells. The secondary oocyte and follicular cells will form the **Graafian follicle**.

The comparison between spermatogenesis and oogenesis

The comparison between spermatogenesis and oogenesis are summarised in Table 15.1.

TABLE 15.1 The comparison between spermatogenesis and oogenesis

Spermatogenesis	Oogenesis
Similarities	
• Both are the processes of gametogenesis that take place in the **reproductive organs**. • Produce **gametes** that are **haploid** which are involved in fertilisation.	
Differences	
It takes place in the testis.	It takes place in the ovaries.
Spermatogonium (diploid) produces four sperms (haploid) after meiosis.	Oogonium (diploid) only produces one functional secondary oocyte (haploid) and three non-functioning polar bodies after meiosis.
Sperms are smaller and made up of the midpiece, head and tail.	Secondary oocytes are large and spherical in shape.
After meiosis I, two secondary spermatocytes are produced.	After meiosis I, one secondary oocyte and one polar body is produced.
Meiosis is completed.	Meiosis II is only completed when a sperm fertilises the secondary oocyte.
Spermatids undergo differentiation to become sperms.	Secondary oocyte does not undergo differentiation.
The production of sperm is continuous from puberty until old age.	The production of the secondary oocyte is not continuous. It starts in the female foetus and remains dormant when the baby is born. The process continues once the female reaches puberty and stops during menopause.
Millions of sperms are formed every day.	Only one secondary oocyte is released from the ovaries at every menstrual cycle.

15.2.3 15.2.4

Formative Practice 15.2

1 What could possibly happen if gametogenesis does not take place?

2 Explain three differences between spermatogenesis and oogenesis.

15.3 Menstrual Cycle

Role of hormones in menstrual cycle

Biological Lens

One of the side effects of low oestrogen is calcium loss in the body which leads to a reduction in bone density, making it porous and weak. This condition is called osteoporosis.

Millennial Career

Obstetricians and gynaecologists are specialists in female reproduction and women's health.

MENSTRUAL CYCLE

The **menstrual cycle** involves the production of a secondary oocyte and thickening of the endometrial wall throughout one cycle. In this cycle, the endometrium will become soft, thick and rich with blood vessels. This is to prepare the endometrium for embryo implantation. If fertilisation does not take place, the secondary oocyte will die and the endometrium wall will shed. This will lead to bleeding known as **menstruation**.

The functions of hormones in a menstrual cycle is shown in Table 15.2.

TABLE 15.2 Functions of hormones in a menstrual cycle

Gland	Hormone	Function
Pituitary	Follicle-stimulating hormone (FSH)	• Stimulates follicle growth in the ovary. • Stimulates the release of oestrogen.
	Luteinizing hormone (LH)	• Stimulates ovulation. • Causes the formation of the corpus luteum. • Stimulates the release of progesterone.
Ovary	Oestrogen	• Repairs and stimulates the thickening of the endometrium. • Stimulates follicle growth until it matures. • Stimulates FSH and LH release prior to ovulation.
	Progesterone	• Stimulates the thickening of the endometrium, making it thick, folded and rich in blood vessels to prepare for the implantation of embryo. • Stops the release of FSH and LH to prevent follicle growth and ovulation.

Changes in hormonal level, follicle growth, and changes in endometrial wall thickness throughout one menstrual cycle are shown in Figure 15.9.

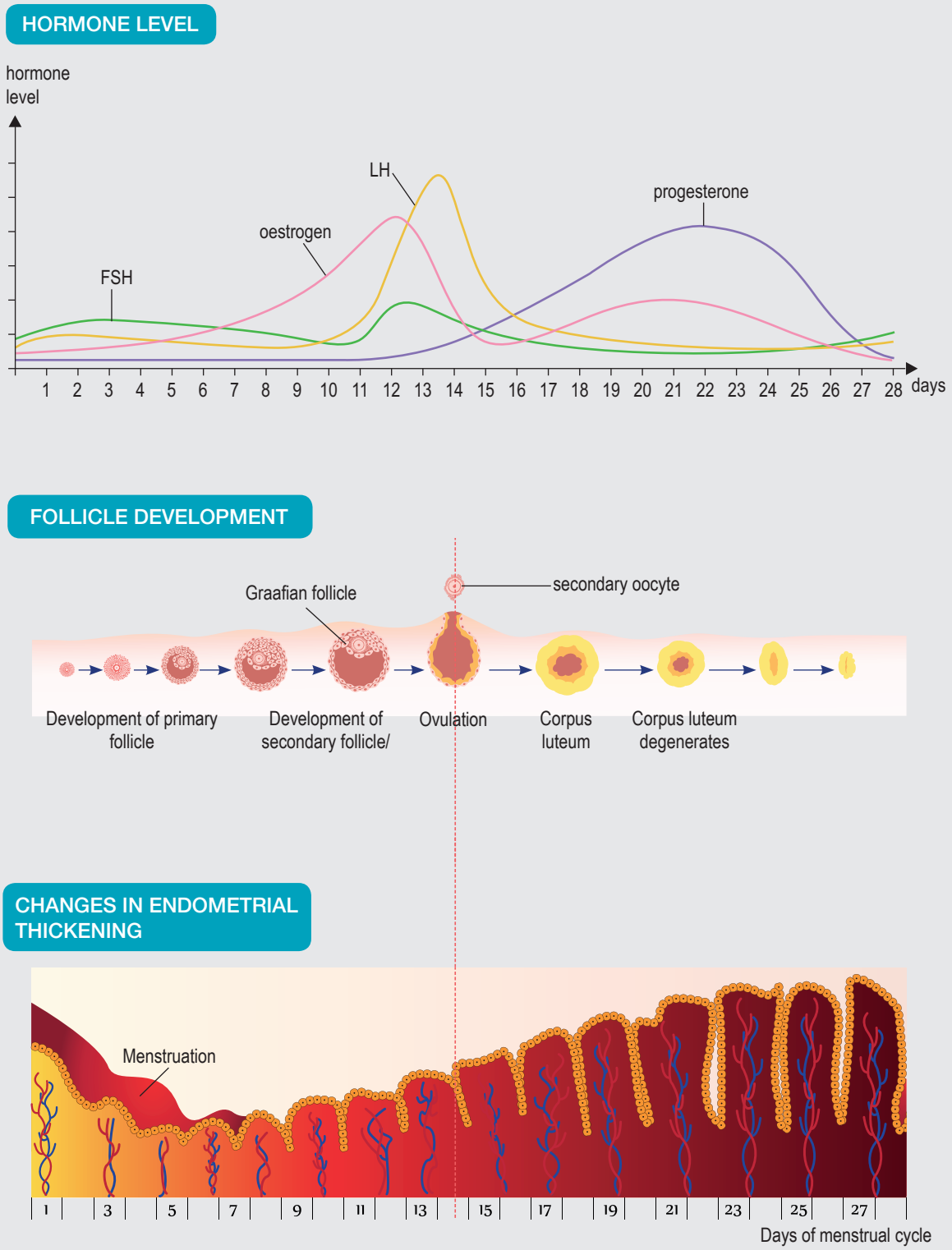


FIGURE 15.9 Stages of events and hormonal level changes in one menstrual cycle

DAY 0–5

- Before a menstrual cycle begins, the level of hormones is low. With the absence of stimulation from progesterone and oestrogen, the thickened endometrium will shed and **menstruation** will begin (first day).
- A menstrual cycle begins a day before menstruation when the hypothalamus releases the gonadotrophin-releasing hormone (GnRH).
- GnRH stimulates the pituitary gland to release the follicle-stimulating hormone (FSH) and luteinizing hormone (LH) into the blood.
- FSH stimulates **follicle growth** in the ovary. Within the primary follicle, the oocyte grows into the secondary oocyte, which is contained within the Graafian follicle.
- Growing follicles release oestrogen.
- Oestrogen encourages follicle maturation and also encourages endometrial wall repair.
- Low levels of oestrogen inhibit the release of FSH and LH via a negative feedback mechanism, which in turn prevents the growth of new follicles.

DAY 6–14

- Oestrogen level rises and peaks on day 12, stimulating the hypothalamus to secrete GnRH via a positive feedback mechanism.
- A high level of GnRH then stimulates the pituitary gland to secrete more FSH and LH.
- The LH level rises until it peaks on day 13, leading to **ovulation** and release of a secondary oocyte from Graafian follicle on day 14.
- LH also stimulates the follicular tissue left behind to transform into the **corpus luteum**.

DAY 15–21

- LH stimulates the corpus luteum to secrete oestrogen and progesterone.
- The combination of oestrogen and progesterone inhibits the release of FSH and LH from the hypothalamus via negative-feedback mechanism so as to stop the growth of new follicles.
- Progesterone stimulates **endometrial wall thickening**, enriching it with blood vessels in preparation for embryo implantation, in the event that fertilisation takes place.

DAY 22–28

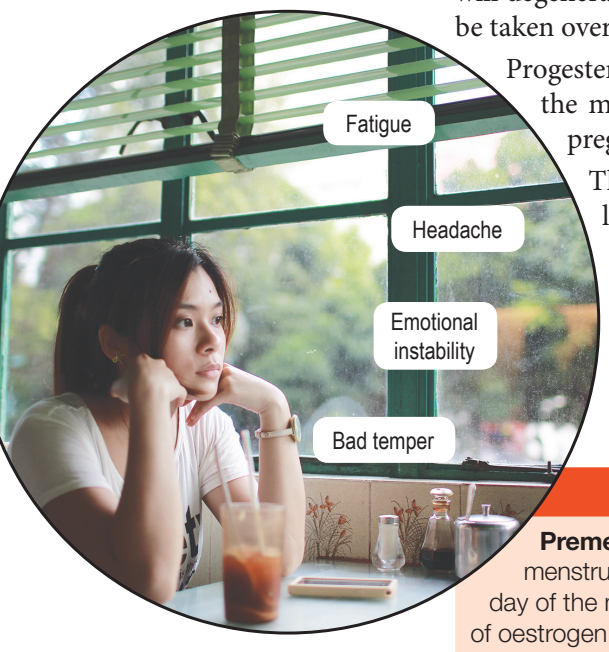
- If fertilisation does not take place, decreasing LH levels will cause the corpus luteum to degenerate, which in turn stops the secretion of oestrogen and progesterone.
- Without stimulation from oestrogen and progesterone, the **endometrium** will **shed** and **menstruation** will begin.
- Low levels of progesterone and oestrogen will no longer inhibit the hypothalamus and pituitary gland, making way for GnRH to be secreted again, which then stimulates secretion of FSH and LH. A new menstrual cycle will begin with new follicle growth.
- If fertilisation occurs, the corpus luteum will continue to grow and secrete progesterone and oestrogen.
- This will cause the endometrial wall to continually thicken in order to support foetal growth.

Role of hormone in pregnancy and miscarriage

The corpus luteum will continue to produce oestrogen and progesterone up to three to four months after pregnancy. Thereafter, the corpus luteum will degenerate, and the production of oestrogen and progesterone will be taken over by the placenta until birth.

Progesterone inhibits the secretion of FSH and LH. Therefore, the menstrual cycle and ovulation do not occur throughout a pregnancy.

The imbalance of progesterone and oestrogen levels may lead to a miscarriage, due to the decrease of progesterone level which causes the uterus to shrink.



PHOTOGRAPH 15.1
Premenstrual syndrome symptoms

Premenstrual syndrome and menopausal syndrome

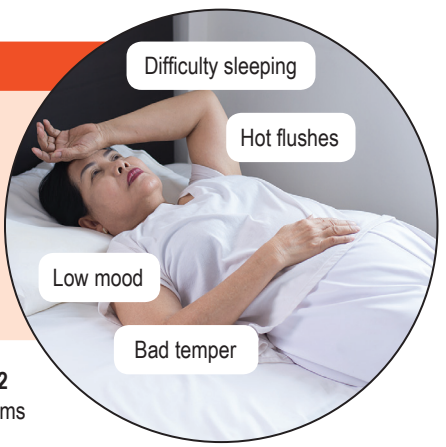
PREMENSTRUAL SYNDROME (Photograph 15.1)

Premenstrual syndrome or symptoms that appear prior to a menstrual cycle usually manifests between 7 to 14 days before the first day of the menstrual cycle. This syndrome occurs due to the imbalance of oestrogen and progesterone hormones within the menstrual cycle.

MENOPAUSE (Photograph 15.2)

Menopause occurs within the ages of 46 to 50 years old, when ovulation and menstruation stop naturally. The increase in age leads to reduced secretion of progesterone and oestrogen, which then causes reduced stimulation of FSH and LH on the ovaries.

At this stage, the ovaries stop producing ovum. After menopause, a woman is not able to conceive a child anymore.



PHOTOGRAPH 15.2
Menopausal symptoms

Formative Practice 15.3

1 State the hormones involved in the menstrual cycle and their functions.

2 Explain the functions of progesterone and its effects on pregnancy.

3 Explain what would happen to the corpus luteum if fertilisation does not occur.

4 In your opinion, what is the best way to overcome premenstrual syndrome?

15.3.2 15.3.3

15.4 Development of a Human Foetus

The process of fertilisation

Fertilisation can occur when one out of the millions of sperm succeeds in penetrating the secondary oocyte in the Fallopian tube. This is followed by changes to the secondary oocyte's membrane that prevents penetration from other sperms. Then, fertilisation occurs when the sperm nucleus fuses with the ovum nucleus to form a diploid zygote.

Biological Lens

Each semen ejaculation contains between 300 to 500 million sperms. However, only about 300 to 500 sperms successfully reach the secondary oocyte in the Fallopian tube.

Early development of an embryo until implantation

- While travelling down the Fallopian tube, the zygote undergoes multiple divisions through mitosis.
- The first cell division produces a two-cell embryo. The following cell divisions will finally produce a **morula**.
- The morula then transforms into a **blastocyst** (Figure 15.10).
- The blastocyst will then implant in the endometrium. This process is called **implantation**. The blastocyst continues to grow into an **embryo**.

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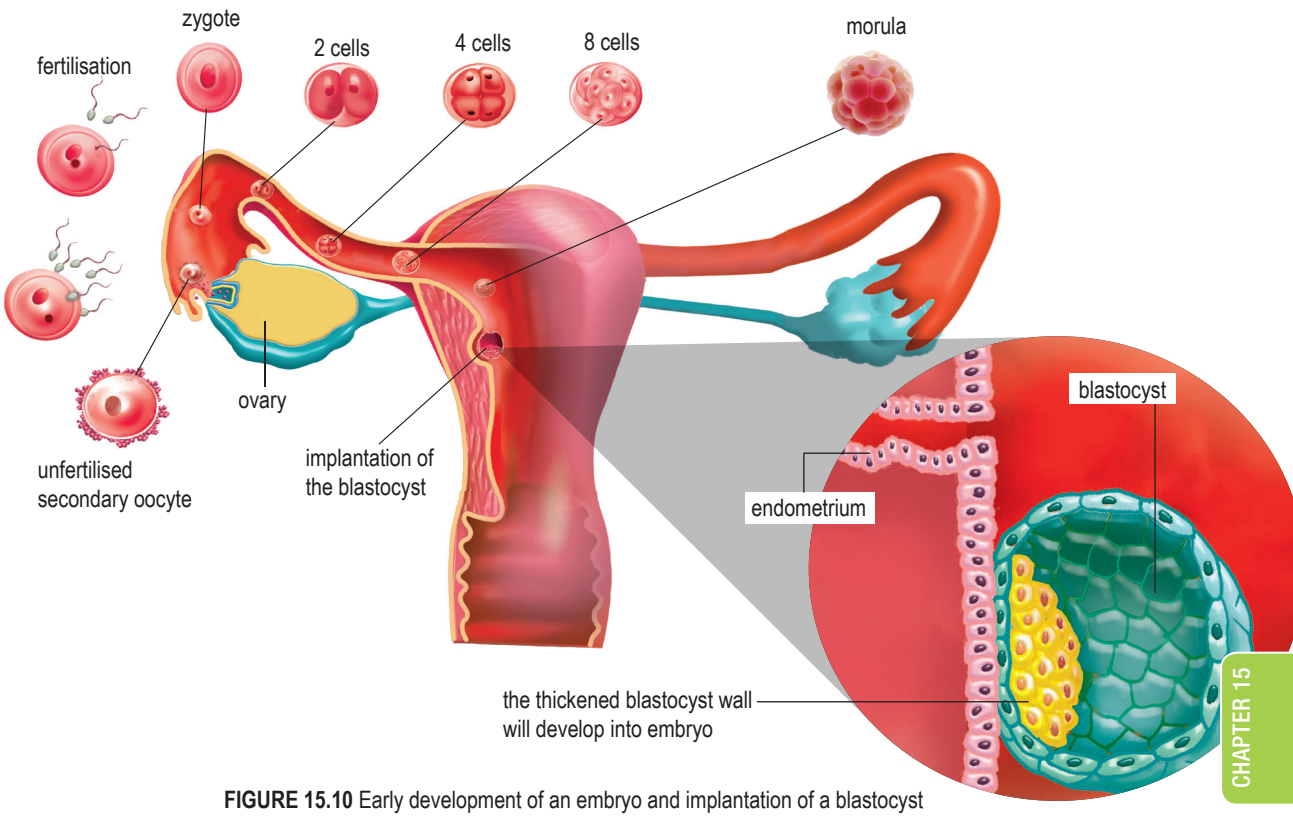


FIGURE 15.10 Early development of an embryo and implantation of a blastocyst

15.4.1 15.4.2

PHOTOGRAPH 15.3
Pregnancy test detects HCG in urine

Role of human chorionic gonadotropin (HCG) hormone

The placenta also produces the **human chorionic gonadotropin (HCG) hormone** during pregnancy. The level of this hormone increases at the early stages of pregnancy and will double every two to three days for the first four weeks of pregnancy. The main function of HCG is to ensure that the corpus luteum continues to secrete oestrogen and progesterone in the early stages of pregnancy. This hormone can be detected in the urine of pregnant mothers.

Role of placenta and umbilical cord in foetal development

The placenta is formed from the mother's endometrial tissue and embryonic tissue. It is connected to the foetus through the umbilical cord which contains blood vessels that carries substance in and out of the foetus.

The **umbilical cord** is a tube that contains the umbilical vein and umbilical arteries.

- The **umbilical vein** carries blood rich in oxygen and nutrients from the placenta to the foetus.
- **Umbilical arteries** carry deoxygenated blood (rich in carbon dioxide) and nitrogenous waste such as urea from foetus to the placenta.

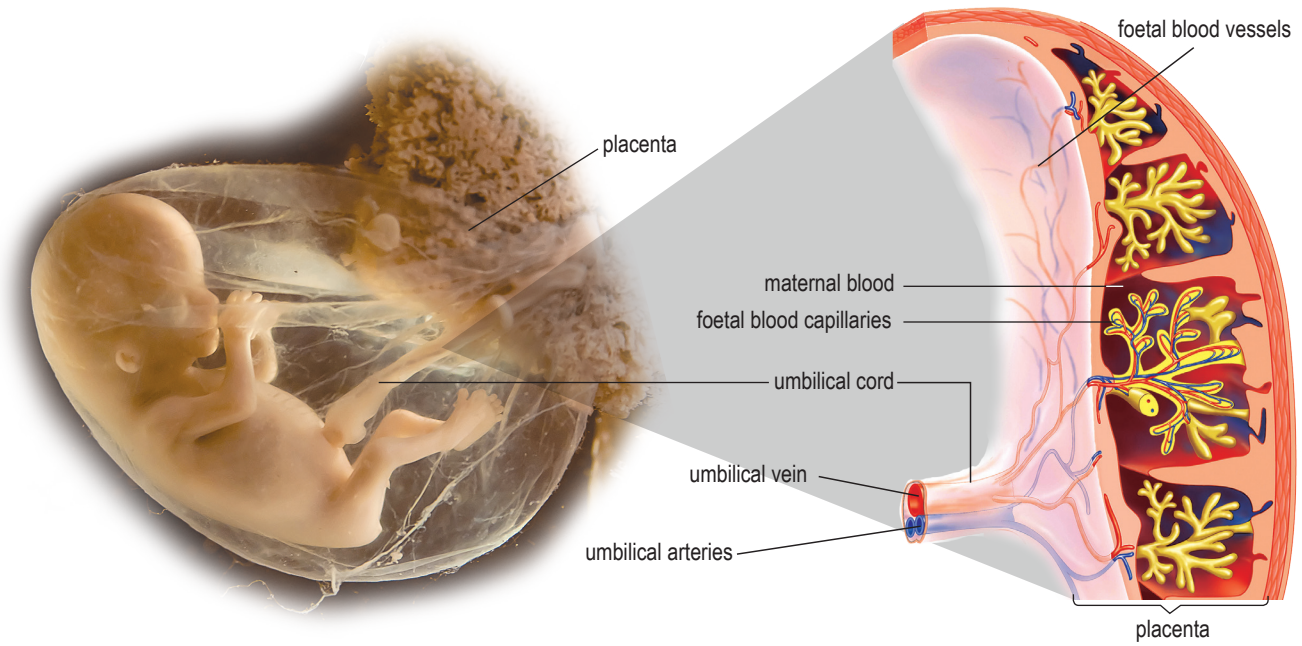


FIGURE 15.11 Placenta and umbilical cord

Importance of placenta

The **placenta** is the exchange site of substances between mother and foetus.

- Glucose, amino acids, hormones, antibodies and oxygen are absorbed from the mother's blood into the foetal blood capillaries.
- Carbon dioxide and nitrogenous waste such as urea are absorbed from the foetal blood capillaries into the mother's blood circulation.

The **placenta** also acts as an endocrine organ that secretes hormones during pregnancy.

- In the fourth month of pregnancy, the corpus luteum will degenerate and no longer secrete progesterone.
- The placenta will replace corpus luteum in producing progesterone and oestrogen needed to maintain endometrial thickness.

Foetal and maternal blood circulatory systems

The blood of the mother and the foetus do not mix as they are separated by a thin membrane. This is important because:

(a) It protects the foetus from certain dangerous chemical substances such as toxins and bacteria that can be absorbed into the foetal blood circulation.

(b) It prevents the thin foetal blood vessels from bursting due to the mother's high blood pressure.

(c) It prevents agglutination or blood clots from happening in the foetus, as the foetus might not be of the same blood group as the mother.

The thin membrane layer is not able to prevent certain substances from being absorbed, such as drugs and medication, cigarette smoke and alcohol ingested by the mother. Viruses such as HIV and rubella can also cross the placenta and be absorbed into the foetal blood circulation, which may disrupt the foetal development.

Formative Practice 15.4

1 Explain the early developmental process of the embryo.

2 What is the main function of the HCG hormone?

3 Describe the function of the placenta.

4 State what might happen if maternal blood mixes with foetal blood.

15.4.4 15.4.5

15.5 Formation of Twins

Process of twin formation

Twins refer to two or more children that are born from one pregnancy. There are two types of twins:

- **identical twins**
- **fraternal twins**

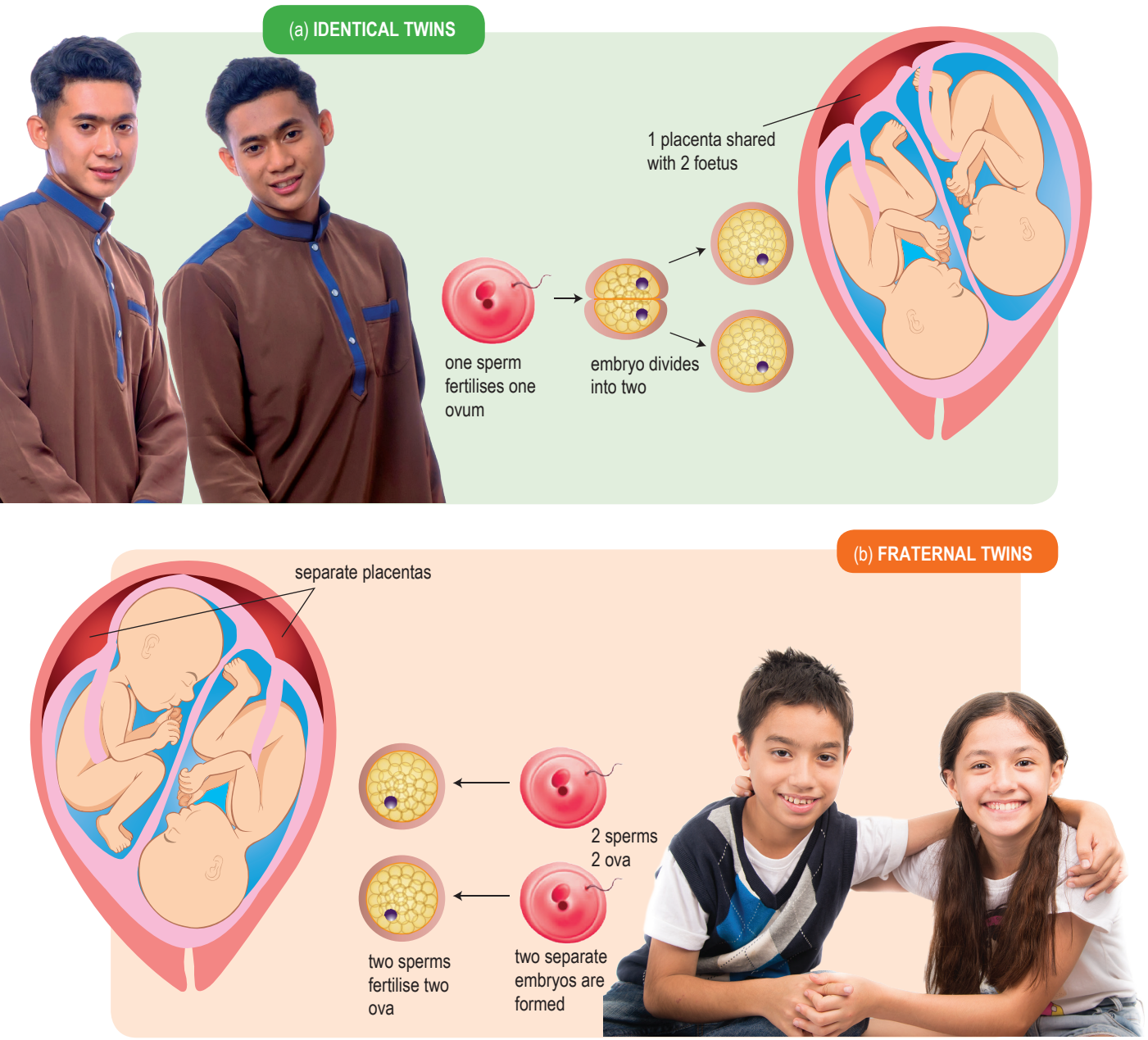


FIGURE 15.12 Development of (a) identical twins and (b) fraternal twins

TABLE 15.3 Differences between identical and fraternal twins

Differences between identical and fraternal twins	
Identical twins	**Fraternal twins**
Product of fertilisation of one ovum and one sperm forming one zygote.	Product of fertilisation of two sperms and two ova forming two zygotes.
Embryo divides into two.	Embryo does not divide into two.
One placenta is shared between two foetus.	Each foetus has its own placenta.
The genetic makeup and physical appearances of these twins are similar as they are from the same zygote.	The genetic makeup and physical appearances of these twins are different as they are from two different zygotes.
The sex of both twins is the same.	The sex of both twins may be the same or different.

Development of conjoined twins

Conjoined twins develop when there is incomplete division of the embryo in identical twins. Although two foetuses are formed from the embryo, some of their physical parts are still fused together, usually the chest, abdomen or buttocks. Conjoined twins may also share one or two internal organs.

The life of conjoined twins may be difficult as they must always be together. They also do not have any time alone. Their movements are limited due to their physical state.

Most conjoined twins die before they are born or have short lifespans. They may be able to be separated through surgery. However, the success of surgery depends on the joined part and what internal organs are shared between them.

PHOTOGRAPH 15.4 Conjoined twins

Formative Practice 15.5

1 State two differences between identical and fraternal twins.

2 State the characteristics of conjoined twins.

15.5.2 15.5.3

15.6 Health Issues Related to the Human Reproductive System

Impotency

Impotency occurs when a husband and wife are unable to conceive. The cause of this might be from the husband or wife, or both.

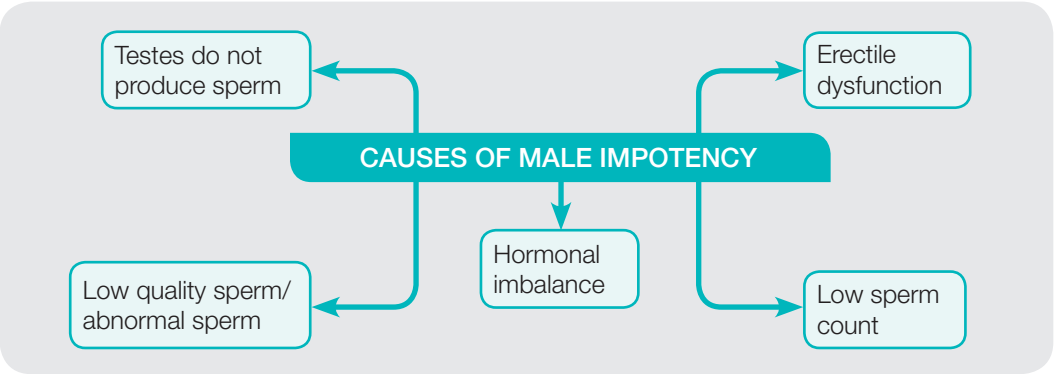


FIGURE 15.13 Causes of male impotency

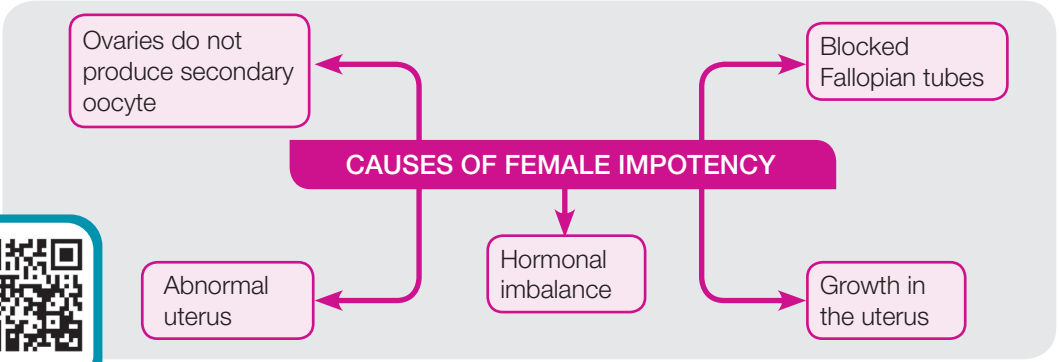


FIGURE 15.14 Causes of female impotency

ICT 15.1

Video: IVF (Accessed on 21 August 2019)

Activity Zone

What are the benefits and drawbacks of science and technological contributions to human reproduction? What moral issues are related to the application of technological reproduction? Discuss.

TREATMENT FOR IMPOTENCY

- Hormonal imbalance can be treated with hormonal therapy.
- Blocked Fallopian tubes or blocked sperm ducts can be treated via surgery.
- *In vitro* fertilisation (IVF) can be used for women who have blocked Fallopian tubes.

Formative Practice 15.6

What are the causes of impotency?

15.6.1 15.6.2

15.7 Growth in Humans and Animals

Growth in organisms

Growth in organisms is an irreversible, permanent process that involves the increase in the number of cells, size, volume and weight of the organism's body. Growth also involves differentiation and cell specialisation as well as specialising the shapes and functions of cells. Growth in organisms is important for the development and maturation of bodily systems.

Measuring growth in humans and animals

The parameters that are used in measuring growth are:

(a) **Increase in size** or **volume**, for example, changes in height or length of an organism

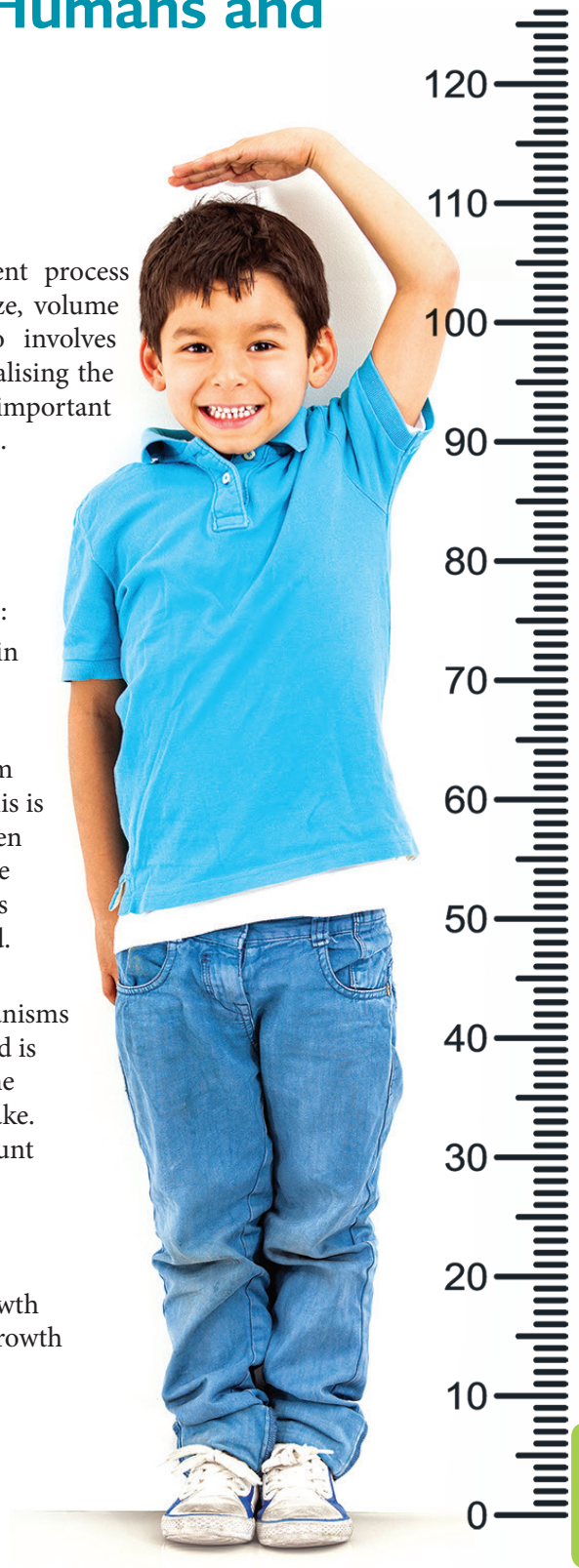
(b) Changes in **fresh weight** or **dry weight**:

  (i) **Dry weight** refers to the weight of an organism after all the fluid is removed from its body. This is done by weighing the organism after it has been dried in the oven at 100 °C repeatedly until the weight remains the same. The weakness of this parameter is that the organism has to be killed. However, this method is suitable for plants.

  (ii) **Fresh weight** can be taken whenever and organisms do not need to be killed. However, this method is less accurate because the amount of fluid in the body is dependent on the organism's fluid intake. This parameter is measured for a certain amount of time.

Growth of Insects

Organisms with exoskeletons like insects undergo growth differently. Insects go through two different types of growth which are **complete metamorphosis** and **incomplete metamorphosis**.



15.7.1 15.7.2 15.7.3

Insects like butterflies undergo complete metamorphosis. In complete metamorphosis, there are four different stages of growth, which are egg, larvae, pupa and adult. Figure 15.15 shows complete metamorphosis.

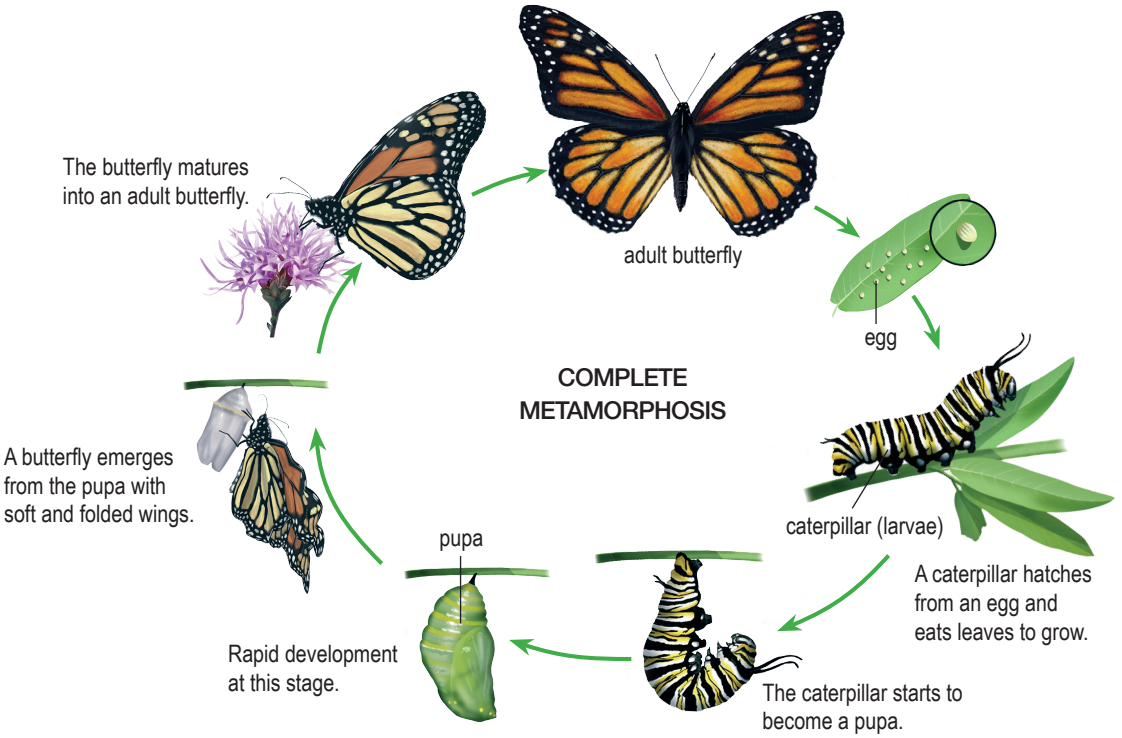


FIGURE 15.15 Complete metamorphosis

Grasshoppers undergo incomplete metamorphosis, where the insect undergoes a few stages of ecdysis before becoming an adult. Figure 15.16 shows incomplete metamorphosis.

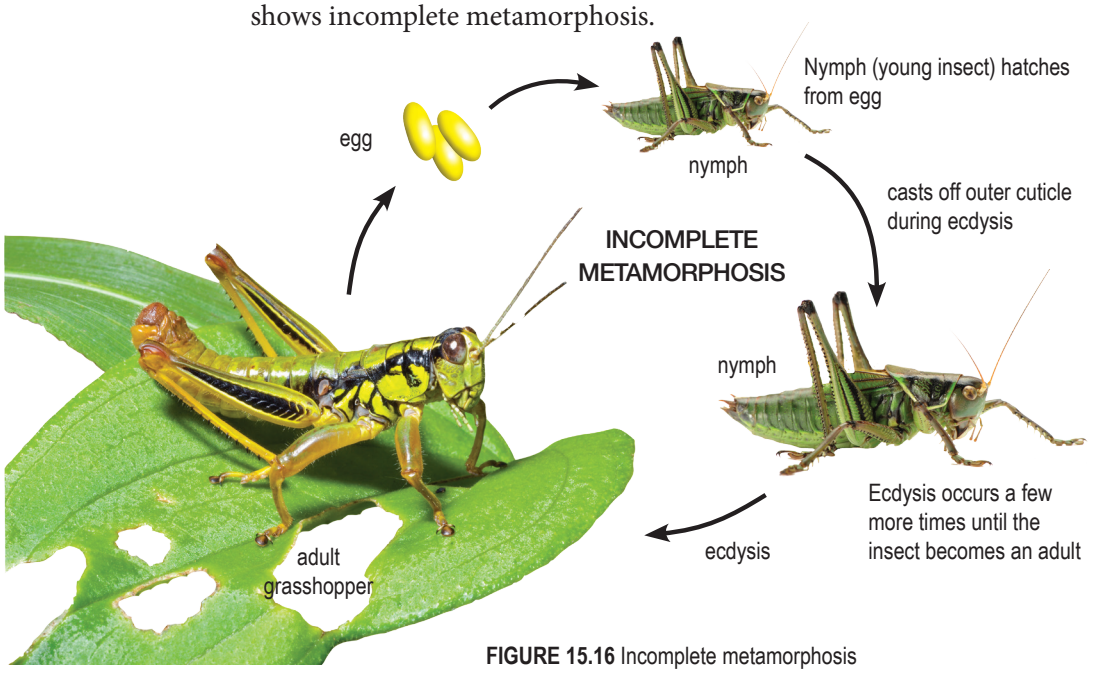


FIGURE 15.16 Incomplete metamorphosis

Growth phases in sigmoid growth curves of humans and animals

The growth curve is achieved by plotting growth parameters against time (Figure 15.17). Most organisms' growth curves show a similar pattern that is a **sigmoid** curve (S-shaped). Growth occurs gradually and continuously. There are six phases in the sigmoid growth curve, which are the **lag phase**, **exponential phase**, **stationary phase**, **maturity phase**, **senescence** and **death phase**.

LAG PHASE

- The growth rate is low because it involves little cell division and cell elongation.
- It is the phase of adjustment to new sources available in the environment.

EXPONENTIAL PHASE

- Highest growth rate.
- Cell division and elongation occurs actively.
- Organism's size increases rapidly.

STATIONARY PHASE

- Growth rate slows down and occurs at a constant rate.
- Cells reach maximum size.
- Cells undergo differentiation to form specialised cells.

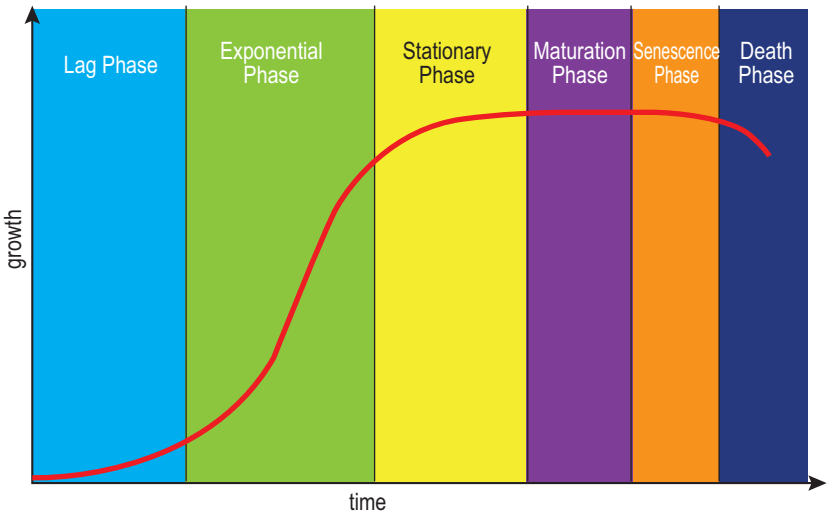


FIGURE 15.17 Sigmoid growth curve

MATURITY PHASE

- Organism reaches maturity.
- Zero growth rate.
- The rate of cell division is similar to the rate of cell death.
- Cell division only happens to replace impaired or dead tissues.

SENESCENCE PHASE

- Negative growth rate.
- Organism goes through ageing.

DEATH PHASE

Ageing, illness, lack of nutrients or space eventually leads to death of an organism.

Intermittent growth curve of animals with exoskeletons

ICT 15.2

Video: Insect ecdysis (Accessed on 21 August 2019)

Insects such as grasshoppers have an exoskeleton made up of **chitin**. The exoskeleton does not grow proportionately with the growth of the insect. To allow growth and development, animals with exoskeletons must shed their hard exterior.

The moulting process of the exoskeleton that allows growth and development of insects is called **ecdysis**. This process is controlled by hormones.

- The process of ecdysis happens **periodically**. Polar growth is **not continuous** and is **intermittent** (Figure 15.18).
- The horizontal part of the graph indicates zero growth. At this stage, known as **instar**, the insect is not increasing in length.
- The vertical lines of the graph represent **rapid** growth.
- At this stage, the nymph undergoes **ecdysis** and its size increases rapidly
- Ecdysis occurs **multiple times** until the insect reaches adulthood.

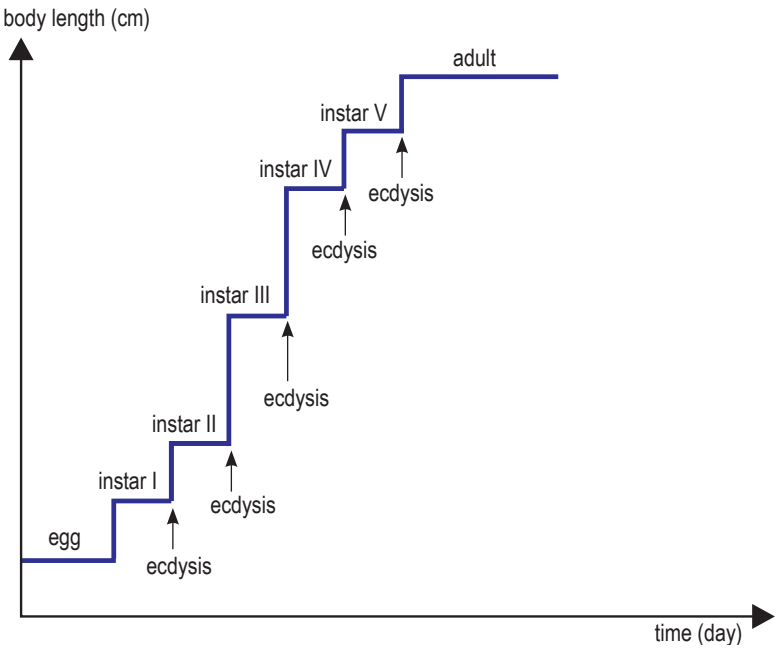


FIGURE 15.18 Growth curve of animals with exoskeletons

PHOTOGRAPH 15.5
A cicada emerging from its old exoskeleton

HOW DOES ECDYSIS HAPPEN?

- A new exoskeleton forms underneath the old exoskeleton
- Before the new exoskeleton hardens, the insect will increase its volume by sucking in air to expand its body
- This action breaks the old exoskeleton and the insect with its new exoskeleton will emerge
- The insect will expand its body one more time before the new exoskeleton hardens

The stages between ecdysis are called **instar** and at this stage, the insect is known as a **nymph**. During instar, the insect is actively building tissue and increasing body volume.

Formative Practice 15.7

1 Describe how to measure growth in animals.

2 Explain the differences between complete and incomplete metamorphosis.

3 Explain the event that happens during the exponential phase.

4 Why must insects go through ecdysis?

Summary

SEXUAL REPRODUCTION, DEVELOPMENT AND GROWTH IN HUMANS AND ANIMALS

Reproductive System of Humans

- Male reproductive system
- Female reproductive system

Gametogenesis

- Spermatogenesis and oogenesis
- Gamete structure: sperm and secondary oocyte
- Comparison between spermatogenesis and oogenesis

Development of Human Foetus

- Fertilisation process and the formation of zygotes
- Role of placenta and umbilical cord in the development of a foetus
- Necessity for separate foetal and maternal blood circulatory systems

Health Issues Related to the Human Reproductive System

- Causes of human impotency

Menstrual Cycle

- Changes in the levels of hormones during:
  - menstruation
  - follicle development
  - thickening of the endometrium
  - ovulation
  - corpus luteum formation
- Changes in the levels of hormones during:
  - pregnancy
  - miscarriage
- Premenstrual syndrome and menopausal syndrome

Formation of Twins

- Identical twins
- Fraternal twins
- Conjoined twins

Growth in Humans and Animals

- Growth of insects with exoskeleton:
  - complete metamorphosis
  - incomplete metamorphosis
- Sigmoid growth curves of humans and animals
- Intermittent growth curve of animals with exoskeletons

Self Reflection

Have you mastered the following important concepts?

- Male and female reproductive systems
- Spermatogenesis and oogenesis
- Gamete structure
- Changes in hormone level, follicle growth, endometrial thickening, ovulation and corpus luteum formation within the menstrual cycle
- Changes in hormone level in a pregnancy and a miscarriage
- Premenstrual syndrome and menopause
- Fertilisation process until the formation of zygote
- Early embryo development until implantation
- Role of human chorionic gonadotropin (HCG) hormone during early pregnancy
- Fetal and maternal blood circulation
- Formation of twins (identical, fraternal, conjoined)
- Health issues related to the human reproductive system
- Sigmoid growth curve of humans and animals
- Growth of insects (complete and incomplete metamorphosis)

Summative Practice 15

1 What causes the premenstrual syndrome in some women?

2 State the differences between the formation of identical and fraternal twins.

3 The foetus has its own blood circulation system, separate from its mother. Explain why.

4 (a) A pair of identical twins were separated at birth. Once they reached adulthood, they found out that they both have different body sizes. Explain the factors that would cause this.

(b) Explain why pregnant mothers must stop smoking.

5 State the changes that occur to a zygote from fertilisation up to birth.

6 A woman took contraceptive pills to prevent pregnancy. The pill inhibits secretions of the Follicle Stimulating Hormone (FSH) from the pituitary gland. Explain the effects of taking contraceptive pills on the menstrual cycle.

7 Figure 1 shows the hormonal regulation of a menstrual cycle.

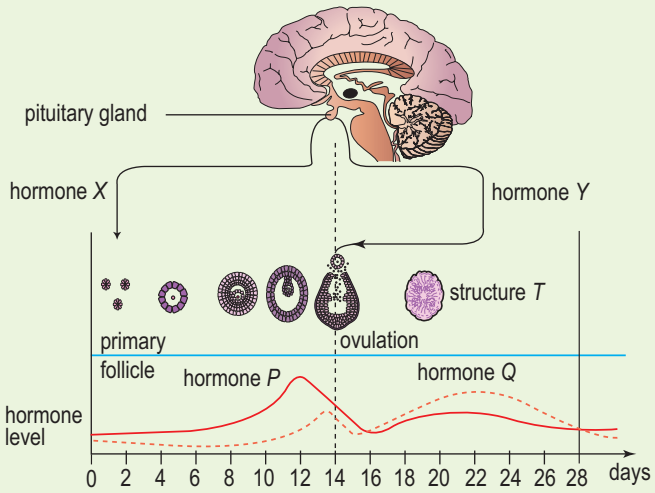


FIGURE 1

(a) State the effect on ovum development if hormone X is not enough.

(b) Explain the effects of hormone P and hormone Y imbalance.

(c) Based on Figure 1, describe the relationship between changes in structure T with the level of hormone P and hormone Q.

(i) from day 16 to day 24

(ii) from day 24 to day 28

8 Figure 2 shows a human foetus inside a uterus.

(a) Name the structures labelled P and Q.

(b) Explain the blood composition that flows through the blood vessel at Q.

(c) Explain the function of structure P.

(d) (i) State the types of immunity a foetus can inherit from its mother.

(ii) Explain how structure P helps in foetal immune response.

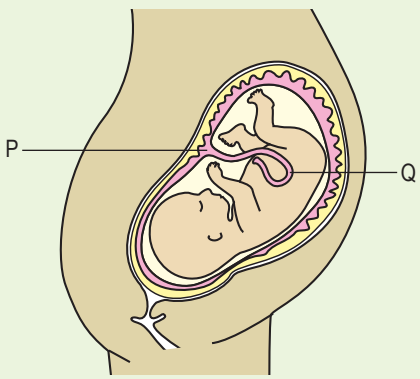


FIGURE 2

Essay Questions

9 A woman having problems getting pregnant needed an injection of hormone X from a specialist. Hormone X has the same function as the luteinizing hormone (LH). After a certain period, the woman was pregnant.
Explain how the hormone X injection can help the woman to get pregnant.

10 (a) Describe the process of sperm production in the testes.

(b) Figure 3 shows the formation of two sets of twins. Compare the formation of the twins R and S.

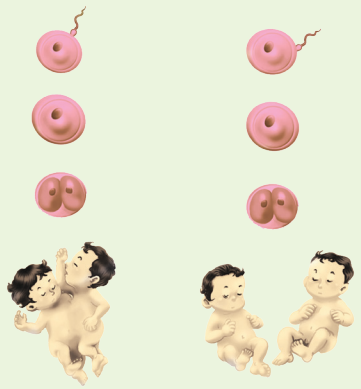


FIGURE 3

Enrichment

11 During ejaculation, approximately 300 million sperms are released. From this amount, only about 300 sperms arrive at the secondary oocyte, and only one will be successful in fertilising the ovum. If only one sperm reaches the secondary oocyte, fertilisation will not take place. Explain why.

12 Describe how changes in different hormone levels in one menstrual cycle prepare a woman for pregnancy.

13 The umbilical cord is the lifeline between the foetus and its mother. Cord blood is blood left in the umbilical cord and placenta after birth. After a baby is born, cord blood is kept as it is a source of stem cells rich in hematopoietic stem cells. Is it important for parents to keep the cord blood for their children's future?

Complete answers are available by scanning the QR code provided