Chapter 13
Birth and development

Unit
2B

Figure 13.1 The birth of a baby is a miraculous event

Unit content

Body systems
Reproductive systems are specialised for support for pregnancy and birth. Reproduction is controlled by hormones.

Development:

- birth process
- comparison of foetal and neonate circulation
- patterns and milestones of development in infants.

The period of pregnancy—the time that the embryo or foetus is carried in the uterus—is called **gestation**. During this period the developing child grows to a length of about 50 cm and to an average weight of 3300 g. This growth and development takes about 280 days, measured from the beginning of the last menstrual period. The date of birth is normally predicted on the basis of the last menstrual period because this date is known and the date of fertilisation is not. The process by which the foetus is expelled from the mother's body at the end of gestation is called **birth**, or **parturition**. Parturition is preceded by a sequence of events commonly called **labour**.

In preparation for labour, several hormonal changes occur. These changes cause the ligaments of the pelvis to soften, making them more pliable for childbirth. The hormonal changes also increase the response of the uterus to stimuli and strengthen contraction of its muscles.

Before labour begins the foetus has probably settled with its head in the mother's pelvis. The cervix has softened, shortened in length, and is likely to have begun to open a little. The foetus is usually facing the woman's right or left hip bone, with its knees drawn up to its abdomen and its legs crossed. In this position it takes up as little room as possible. One side of its head is usually pressed against the mother's bladder, the other against her bowel (Fig. 13.2).

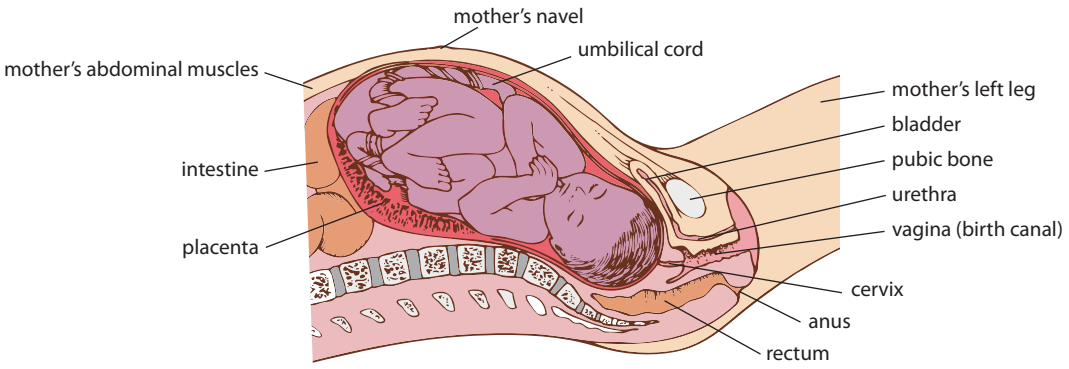

Figure 13.2 The foetus just before birth. Note how the head of the foetus has settled into the woman's pelvic cavity

The first stage of labour

During the final three months of gestation, the uterus undergoes weak, irregular contractions. These contractions gradually become stronger and more frequent during the final weeks of pregnancy. Eventually the contractions become quite strong and occur about every 30 minutes. This is the beginning of the birth process and the contractions are known as **labour pains**.

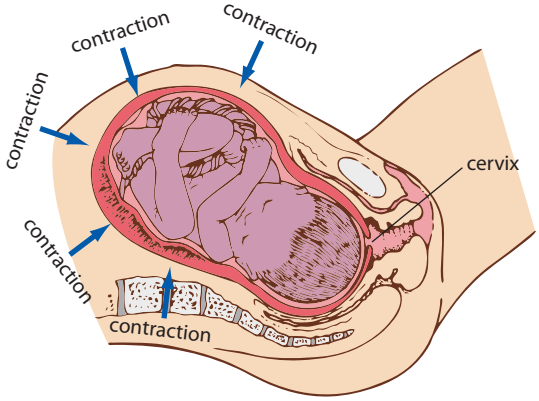

Figure 13.3 The first stage of labour

The first stage of labour, the **dilation of the cervix**, is the time from the onset of labour to the complete dilation (or opening) of the cervix. Although variable in length, it lasts an average of 8–9 hours for the first labour and about 4 hours for the birth of subsequent children.

Waves of contraction travel from the upper part of the uterus downward towards the cervix. These waves are similar to the peristalsis that occurs in the alimentary canal to push food along. With each contraction, the muscle fibres making up the uterus shorten a small amount, pulling on the cervix. This pull on the cervix shortens it so that it no longer projects down into the vagina (compare Figs 13.2 and 13.3). At the same time, the cervix is opened. This **cervical dilation** allows the foetus to move more deeply into the pelvis.

As the contractions become more frequent and stronger, the head of the foetus is pushed more forcefully against the slowly dilating cervix. Eventually the cervix is completely dilated (usually to about 10 cm), and the uterus, cervix and vagina form a single, curved passage. This passage, termed the **birth canal**, is the route through which the foetus will pass, aided by the contractions of the uterus and voluntary contractions of the abdominal muscles of the mother. Complete dilation of the cervix marks the end of the first stage of labour.

The second stage of labour

The second stage of labour involves the delivery of the foetus and is often called the **stage of expulsion**. It frequently begins with the bursting of the membrane surrounding the foetus and a gush of fluid from the vagina. This may occur much earlier in labour or, occasionally, may not occur until the foetus is ready to be born. In most cases, however, it occurs at the beginning of the second stage of labour.

The second stage, from full dilation of the cervix to birth, lasts from 20 minutes to 2 hours. As the foetus moves through the fully dilated cervix its head stretches the vagina. This distension of the vagina stimulates the woman to contract her abdominal muscles. These contractions, together with the contractions of the uterus, push the foetus through the vagina. As this occurs, the baby's head turns to face towards the mother's back.

With each contraction, the head advances a small amount. Between contractions it retreats a little, but overall the head gradually moves through the external opening of the vagina. As this occurs, more and more of the head becomes visible (Fig. 13.4). During this time the mother is working very hard (she is really in labour!). Her pulse rate increases and she usually begins to sweat from the effort required. Between contractions the mother tries to rest a little to gain strength for the next effort. Eventually the head stretches the vaginal entrance and the tissues between it and the anus. This tissue becomes tightly stretched over the foetus's head as it is forced into the world (Fig. 13.4). Once the head has emerged, it turns sideways again to face the mother's hips. This rotation allows the shoulders and the rest of the body to move more easily through the birth canal.

As the foetus passes through the birth canal the pressure on the head may cause it to be pushed out of shape. This produces no damage to the underlying brain, as the bones of the skull are pliable and separated by joints that allow some degree of overlap. The head resumes its normal shape a few days after birth.

The head of the foetus is downward in over 90% of births. This position allows the head to be delivered first and to act as a wedge to force open the cervix and the vagina. The head-down position also allows the foetus to begin breathing even before it is completely free of the birth canal.

The third stage of labour

Once born, the baby begins to breathe with its own lungs, even though it is still connected to the placenta by the umbilical cord. The amnion, chorion and placenta are still inside the uterus at this stage. The umbilical cord is clamped, tied in two places, and then cut between the ties by the doctor or midwife attending the birth. The arteries and vein within the umbilical cord contract, either before or immediately after they are cut. After a few days, the stump of the cord dries up and falls away. The navel, or **umbilicus**, is all that remains.

At birth the baby is covered in a waxy material called the **vernix**. This is a protective layer and in the past it was washed off the baby during its first bath. It is now more

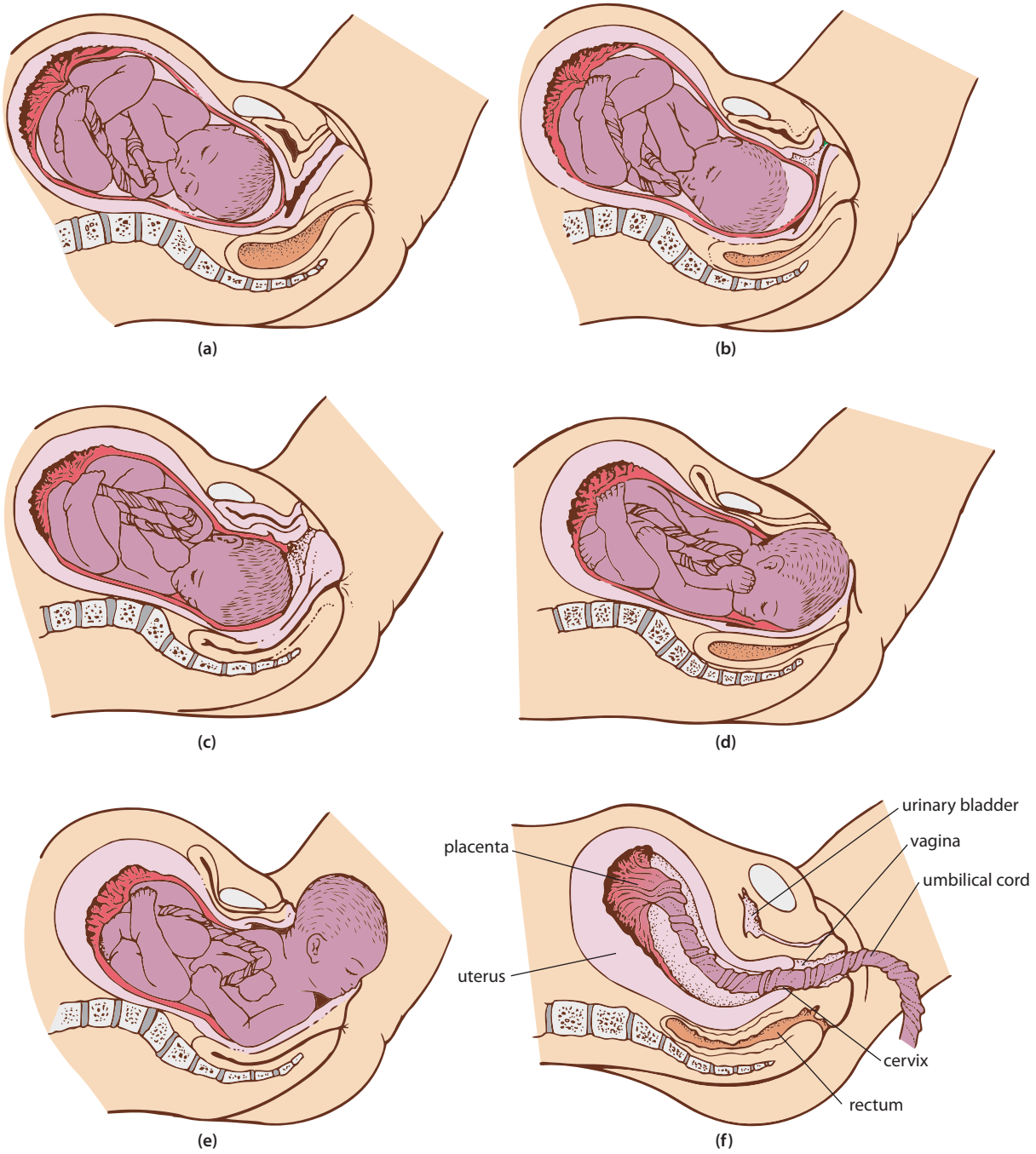

Figure 13.4 Stages of birth: **(a)** the baby in early labour: at this stage the amnion is still intact; **(b)** late in the first stage of labour: the cervix has almost completely opened and the amnion is bulging in front of the head; **(c)** early in the second stage of labour: the baby's head is starting to turn so that it faces towards its mother's back and the amnion has ruptured; **(d)** late in the second stage: the baby's head appears at the entrance to the vagina and its shoulders are turning to fit into the bones of the pelvis; at this stage the face is turned completely towards the mother's back; **(e)** the baby's head emerges from the vagina; **(f)** the third stage of labour: the afterbirth is expelled from the uterus

common to clean the baby with a cleansing agent that does not remove all the vernix. A thin, invisible layer is left on the baby's skin. Since this practice has been adopted, the incidence of skin infections in babies has been greatly reduced.

The uterus continues to contract, and about five minutes after delivery the placenta, other membranes and remains of the umbilical cord are expelled. Together these are called the **afterbirth**. Little blood is lost during this stage as the placental blood vessels constrict and contractions of the uterus squeeze shut the uterine vessels that supply blood to the placenta. Blood clots then form to stop all leakage of blood. With such a large area of exposed tissue, infection can occur. In the past this was quite common and made childbirth hazardous, with many women dying from infection of the uterus. Today, with strict standards of cleanliness and the availability of antibiotics, women seldom die from infection following childbirth.

EXTENSION

In some pregnancies, and for a variety of reasons, the doctor looking after the woman may decide to **induce** labour. Reasons for this may include high blood pressure, bleeding, incompatibility of blood groups between foetus and mother, or a pregnancy that has gone on for more than 42 weeks. However, for most women, labour starts quite naturally.

- Find out about the initiation of labour under natural circumstances.
- Does medical intervention to induce labour mimic the natural process? Describe the similarities and differences.
- How long do such induction techniques take to be effective?

Characteristics of the newborn infant

At birth, full-term babies are, on average, 50 cm long, and weigh 3.3 kg (Fig. 13.5). Males are slightly larger in all body dimensions than females. However, there is a great range in the size and weight of babies at birth and in their subsequent rate of growth. The figures quoted here should be taken only as a general indication of physical development.

Figure 13.5 A newborn baby

The head makes up one quarter of the overall length of a newborn child and the legs only one-third (see Fig. 13.11). If the newborn is held vertically under the arms, the head lolls forward and the bowed legs hang helplessly as muscle control has not yet developed. However, a newborn baby should not be considered entirely helpless. From the moment a baby is born, it can breathe, suck, swallow and get rid of wastes. It can see (but not to the same extent as an adult), hear, taste, smell and turn the head. In addition, from the first minutes of life, a baby cries out to signal for help.

Reflexes govern most of the movements of newborn babies. That is, they occur automatically in response to a particular stimulus. For example, placing an object such as a finger in the baby's mouth stimulates the sucking reflex. This is an important reflex for a baby to obtain milk from the mother's breasts.

Changes in the baby at birth

During development, the embryo—and later the foetus—is totally dependent on the mother for all its needs. The mother supplies the foetus with oxygen and nutrients, eliminates carbon dioxide and other wastes, and protects it against changes in temperature, shocks and many disease-causing organisms. At birth all of this changes: the infant has to become self-supporting.

Before birth, the lungs of the foetus do not function and it obtains its oxygen from the placenta. In the same way, it gets its nutrients from the placenta rather than from its own alimentary canal. These important differences between the foetus and the baby after birth mean that the circulation must change when the baby is born (see Fig. 6.4 for a diagram of the normal circulation).

Before birth, foetal blood is carried to and from the placenta by blood vessels in the umbilical cord. The baby's blood is carried to the placenta in two umbilical arteries. As it circulates through the placenta, carbon dioxide and other wastes are exchanged for oxygen and nutrients. The blood then returns to the foetus via the umbilical vein. Some of the blood returning to the foetus flows through the liver and into the inferior vena cava (the main vein taking blood to the heart from the lower body). The remainder bypasses the liver by flowing through a vessel called the **ductus venosus**, and then into the inferior vena cava (Fig. 13.6). The fact that much of the blood does not pass through the liver causes no problems at this stage, as the mother's liver is serving the needs of the foetus.

Blood returning to the foetal heart enters the right atrium. From there it can follow several pathways:

- Blood may flow into the right ventricle and then to the lungs in the usual way. However, the lungs are collapsed and not functioning at this stage, so they offer a considerable resistance to blood flow and little blood reaches the lungs.
- Most of the blood from the right ventricle flows through the ductus arteriosus to the aorta (the artery that carries blood to the body). The **ductus arteriosus** is a lung bypass, which allows blood in the pulmonary artery (that carries blood to the lungs) to flow directly into the aorta.
- Blood in the right atrium of the heart may flow directly into the left atrium through an oval opening between the two chambers. This opening is called the **foramen ovale**. As Figure 13.6 illustrates, the foramen ovale is located so that most of the blood entering the right atrium goes through it. This is beneficial as the blood coming from the placenta is highly oxygenated and can flow to the developing foetal tissues via the aorta very quickly.

At birth the newborn can no longer depend on the placenta for food and oxygen. The lungs and liver must now become fully functional and for this to occur blood

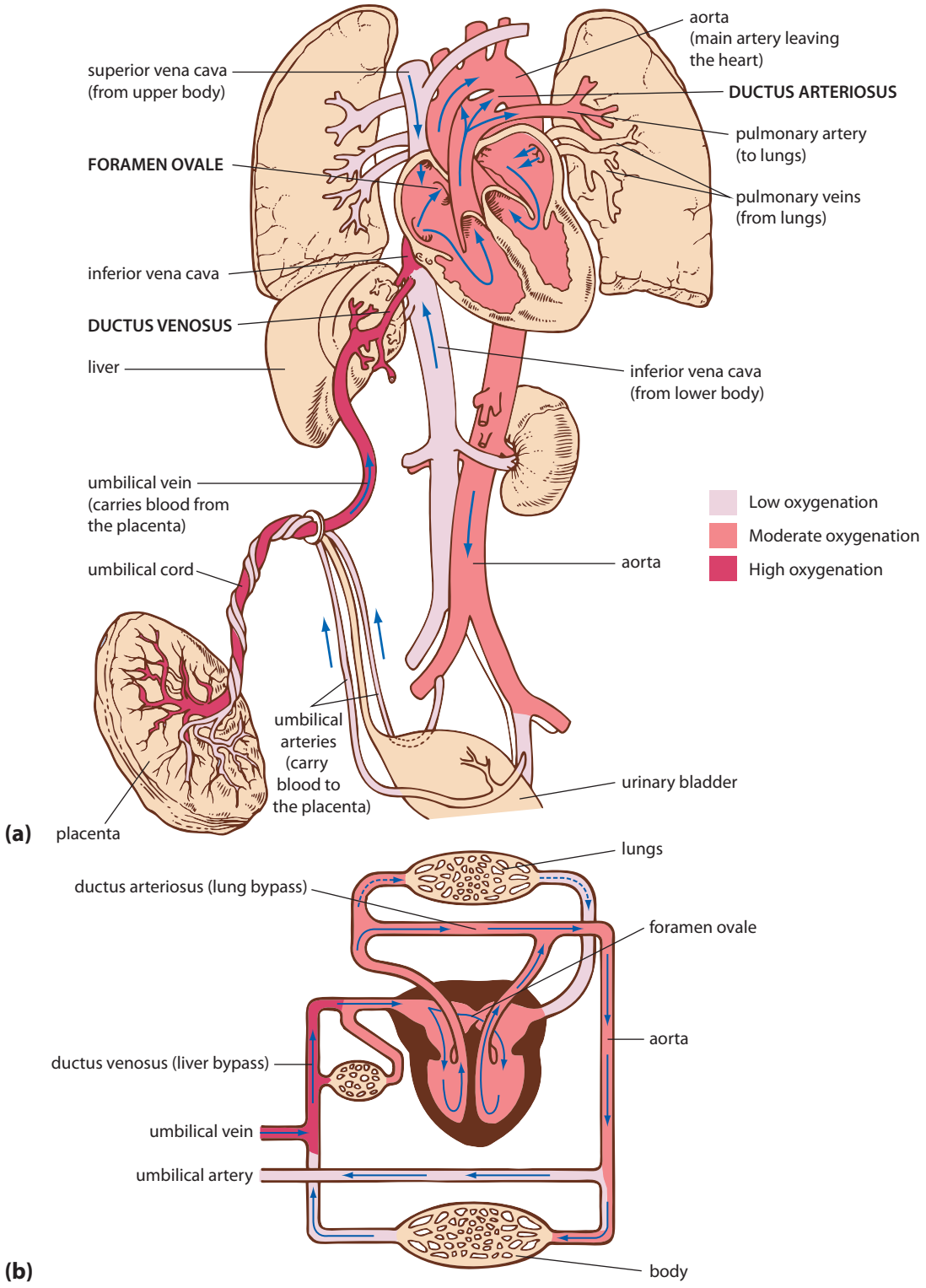

Figure 13.6
(a) Foetal circulation; **(b)** schematic diagram showing flow of blood more clearly

must flow through them. The first breath of life is usually triggered by the shock of birth. If not, the traditional slap on the baby's bottom provides a stimulus that initiates breathing. Failing this, the clamping of the umbilical vessels allows the level of carbon dioxide in the baby's blood to rise. This stimulates the respiratory centre in the brain and as a result the lungs begin to function. As the lungs expand they no longer offer the same resistance to blood flow, so blood flow through the ductus arteriosus begins to decrease. A few weeks after the birth all that is left of the ductus arteriosus is some

fibrous tissue (Fig. 13.7). As larger amounts of blood return to the heart from the lungs, the pressure in the left atrium increases. This increased pressure forces the flap of the foramen ovale against the wall of the atrium, closing off the opening. Eventually the foramen ovale becomes permanently closed (Fig. 13.7b).

If the foramen ovale fails to close, the baby may be born with a 'hole in the heart'. The first indication of this is at birth, as the baby has a bluish colour due to insufficient oxygen in the blood. Because the foramen ovale is still open, not enough blood flows

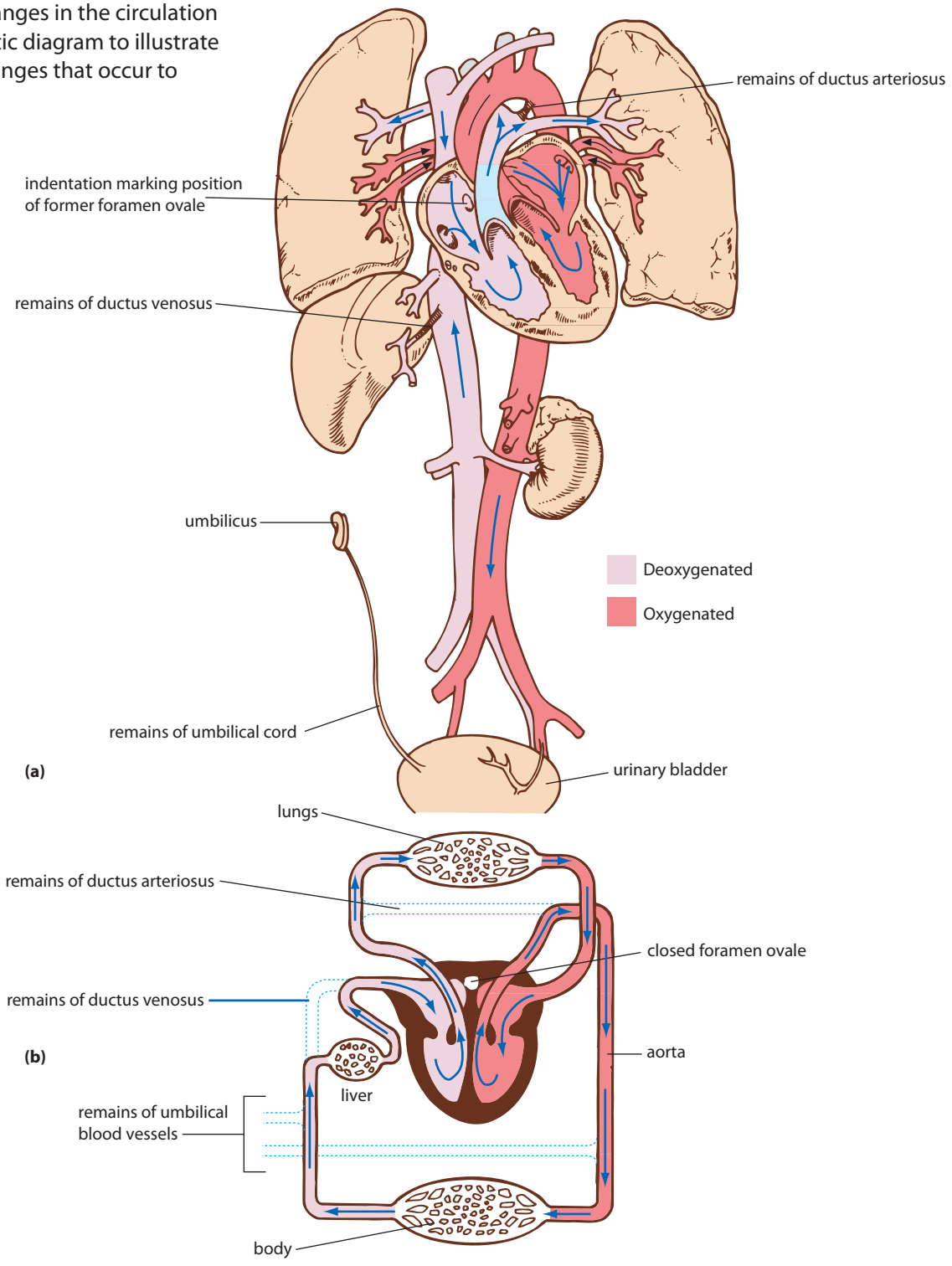

Figure 13.7 **(a)** Changes in the circulation at birth; **(b)** schematic diagram to illustrate more clearly the changes that occur to blood flow

through the lungs. Surgery can be performed to close the foramen ovale and provide normal circulation.

With the cutting of the umbilical cord, blood no longer flows through the umbilical vessels or the ductus venosus. As no blood is being carried through it, the ductus venosus gradually constricts until it is permanently closed off. The bypass around the liver is then lost and all blood in the blood vessel to the liver must pass through the liver.

Following birth the baby breathes rapidly, at about 45 breaths per minute for the first two weeks. The breathing rate then gradually slows. Similarly, the heart rate of the newborn is high: it may be from 125 to 130 beats per minute, often going as high as 180 beats per minute at times of excitement. The rate is high because more oxygen is needed for increased muscular activity and to keep the baby warm in the cooler environment outside the uterus. For the same reason the number of red blood cells increases to carry extra oxygen to the tissues. The white blood cell count, on the other hand, is very high at birth, but decreases rapidly by the seventh day.

You can find out more about the changes to the circulation before and after birth at http://www.indiana.edu/~anat550/cvanim/fetcirc/fetcirc.html

EXTENSION

Babies born before 37 weeks of gestation are referred to as premature, and it is not usual for a baby born before 23 weeks of gestation to survive. However, in October 2006 in Miami, USA, a baby girl, Amillia Taylor was born just 21 weeks and 6 days after conception. She was delivered by caesarean section and was breathing without assistance. She even made several attempts to cry when she emerged. At the time Amillia was the most premature baby known to have survived.

Find out:

- the birth weight and size of a baby born after 22 or 23 weeks of gestation
- what complications very premature babies are likely to face
- what special care is necessary to keep very premature babies alive
- the survival rate of babies born prematurely.

Changes to the mother after childbirth

The changes to the mother after childbirth are not as dramatic as those that take place in the baby. Following childbirth the reproductive organs, particularly the uterus, slowly return to their non-pregnant state. This period, which lasts about eight weeks, is called the **puerperium**. After delivery, the uterus continues to contract. For most women these contractions are painless, but in some they are painful for the first few days following the birth. Within two weeks the mother is no longer able to feel the swelling within her abdomen, and by the end of puerperium the uterus has completed shrinking (Fig. 13.8). Contractions and gradual shrivelling of the muscle fibres bring about the shrinking. This flattens the abdomen, one of the most visible changes occurring after childbirth. Another visible sign is a discharge of fluid from the slowly shrinking uterus. The fluid is a mixture of blood and the breakdown products of tissues, which is discharged as the uterus gradually becomes smaller. Normally the discharge stops around the end of the third week, but it can persist for up to six weeks.

A number of other changes occur during the puerperium. The blood volume that increased during pregnancy gradually returns to normal. The pulse is often slower and the body temperature a little above normal. Emotional changes accompany childbirth: by about the third day the excitement of having a new baby has started to diminish.

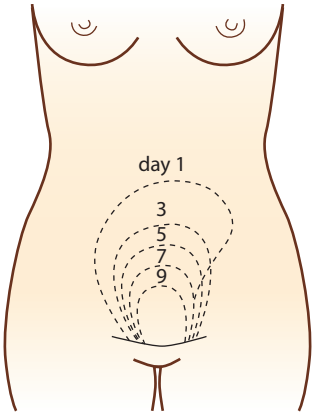

Figure 13.8 The uterus returning to its normal size

The demands of the baby may be starting to take their toll and postnatal (after birth) depression may occur. These bouts of depression, often called the 'third-day blues', appear for no apparent reason. Often things appear to be going very well when suddenly the mother will burst into tears. Childbirth is an emotional experience, and these mood changes may be just a way of adjusting to the new situation.

The return of menstruation shows that the reproductive system is back to normal after the pregnancy. If the mother is breastfeeding, menstruation is frequently delayed for about six months or more. It can start much earlier but rarely returns during the first 20 weeks of breastfeeding. Women who are not breastfeeding, on the other hand, usually start menstruating again about 10 weeks after the birth of the child.

The structure of the breast and milk production

Prior to puberty the breasts in both sexes are similar. At about age 10 or 11 in females, the nipple area bulges and the nipple projects from the centre. This is caused by the influence of hormones secreted by the ovaries. The absence of significant quantities of such hormones in the male means that the male breasts remain undeveloped.

The female breast consists of 16–25 sections, called **lobes**, each of which is subdivided into a number of **lobules**. The wall of each lobule is made up of a large number of glandular **alveoli** (Fig. 13.9), which are the milk-secreting regions of the breasts. The lobules and lobes are surrounded by fatty connective tissue, which gives the breast its rounded contour. From the lobules, ducts open into wide spaces. These milk spaces serve as reservoirs for the milk produced by the alveoli. From each space a short, straight duct leads to the nipple. As each lobe has its own milk space, there are between 15 and 25 openings on the nipple for the secretion of milk.

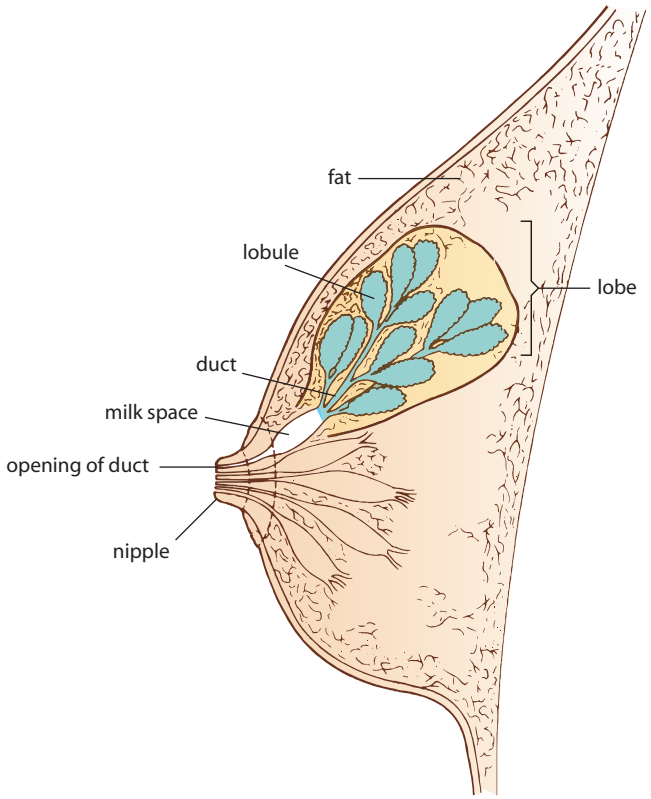

Figure 13.9 Structure of the breast

Lactation

Lactation refers to the *initiation and maintenance* of milk secretion, as well as the delivery of milk to the infant. Early in pregnancy, the increase in levels of circulating hormones causes changes in the breasts. The lobes become more complex and larger in size, and oil-secreting glands around the nipple enlarge.

A day or two after birth, milk secretion begins. However, for some women secretion may begin even earlier than this. The first secretion is a watery, yellowish white fluid called **colostrum**. Colostrum has a similar composition to milk but contains little or no fat and has a high content of the mother's antibodies. These antibodies can be absorbed through the infant's intestine to give temporary immunity to those diseases to which the mother is immune. Although milk secretion begins shortly after the child is born, the milk remains stored within the breast until suckling begins.

Once the nipples are suckled an automatic response called a **milk let-down reflex** is triggered, and milk begins to flow. This let-down reflex is relatively complex (Fig. 13.10). As the baby suckles the nipple, nerves in the nipple are stimulated and messages are sent to the brain. The brain instructs the pituitary gland to release a hormone called oxytocin. Oxytocin triggers the contraction of the small muscles surrounding the milk-filled lobules of the breast.

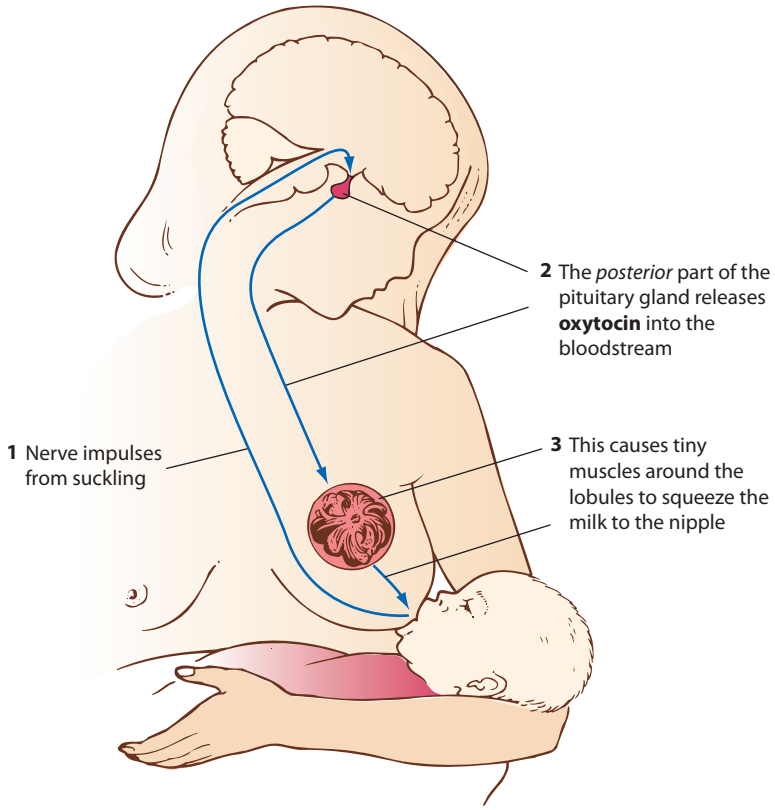

Figure 13.10 Milk let-down: the nerve impulses from suckling result in oxytocin being released into the bloodstream; oxytocin stimulates the small muscles around the lobules to contract, forcing milk towards the nipple

As a result, the milk is ejected into the ducts. The suckling infant can then draw the milk through the openings on the nipple.

At the height of lactation, up to 1.5 L of milk may be formed each day. To supply the nutrients necessary for prolonged lactation the mother must have a well-balanced diet. In particular, her diet should contain adequate supplies of calcium, phosphate and vitamin D—otherwise calcium for milk production may be withdrawn from her own bones and teeth. (Breast feeding is discussed in further detail in Chapter 22.)

EXTENSION

A woman who is breastfeeding her baby left the baby at home and went to a shopping centre. While in the centre she heard another woman's baby crying and noticed that her breasts were exuding milk.

Find out:

- the psychological link between hearing a baby crying and the let-down reflex of milk.

Development in infancy

Physical development

Remarkably rapid and extensive growth changes take place during the first year of the child's life. Body length increases by over one-third, and weight almost triples. By the time a child reaches the end of the first year, height is about 71–74 cm and weight about 9 kg. However, not all parts of the body grow at the same rate so that the infant's

overall body proportions change rapidly, particularly during the second half of the first year. This change in body proportions can be illustrated by the differing growth rates of the legs and head. A newborn's legs are about one-fifth as long as they will be at maturity, but from about two months of age they grow rapidly. In contrast, the head and face grow more slowly than the body as a whole. This reflects the initially high head-to-body ratio at birth. Although skull size and shape change significantly, the changes are nowhere near as dramatic as in the legs. Figure 13.11 shows a two-month-old foetus, which has a head about one-half of the total body length. At birth this proportion changes to about one-quarter, and in adulthood the head makes up only about one-tenth of the total body length.

For the first few years of life, physical growth occurs at a remarkably fast rate, but by the age of six, growth has begun to slow down. The change in the steepness of the graph in Figure 13.12 indicates this. During the middle childhood years of ages 6–11, height increases at a rate of 5–6% per year, whereas weight is gained at a little over 10% per year (Fig. 13.13). Until their tenth year males are, on average, slightly taller than females. From then until about age 15 the average female is slightly taller than the average male. This pattern is similar for weight. By age 15 body proportions are much the same as those of adults.

Motor development

When babies learn to control movement of part of the body they are said to be developing **motor skills**. The development of these skills involves the coordination of muscles. As some muscles contract, others must relax. This coordination involves the nervous system sending messages to the appropriate muscles at the appropriate time. Motor skills such as grasping, throwing, walking, running, riding a bicycle or writing are learned by practice, and by trial and error. Eventually they can be performed without any conscious thought. The development of such skills is called **motor development**.

There are three patterns involved in motor development:

1. The **cephalocaudal** pattern, or development from head to foot. Movements of the head develop earlier than those of the hands, and coordination of the hands is achieved before coordination of the legs and feet (e.g. an infant is able to follow an object with the eyes long before it is able to reach out and grasp it; later still, standing and walking are achieved).
2. The **proximodistal** pattern, or development outwards. Movements of those parts of the limbs close to the body are able to be controlled first (e.g. an infant learns to control the upper arm before the forearm, then the hand and then the fingers). Fine movements of the fingers are the last to be mastered (Fig. 13.14).

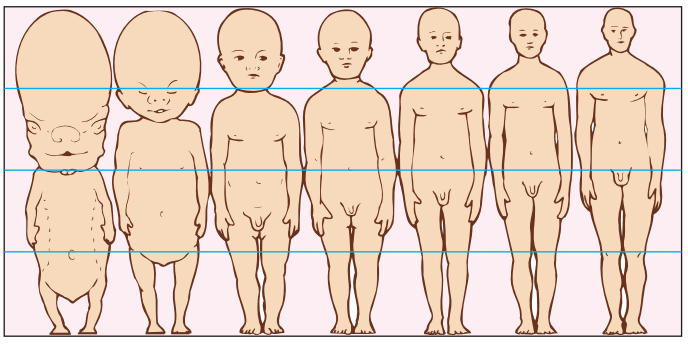

Figure 13.11 Changes in form and proportion of the human body

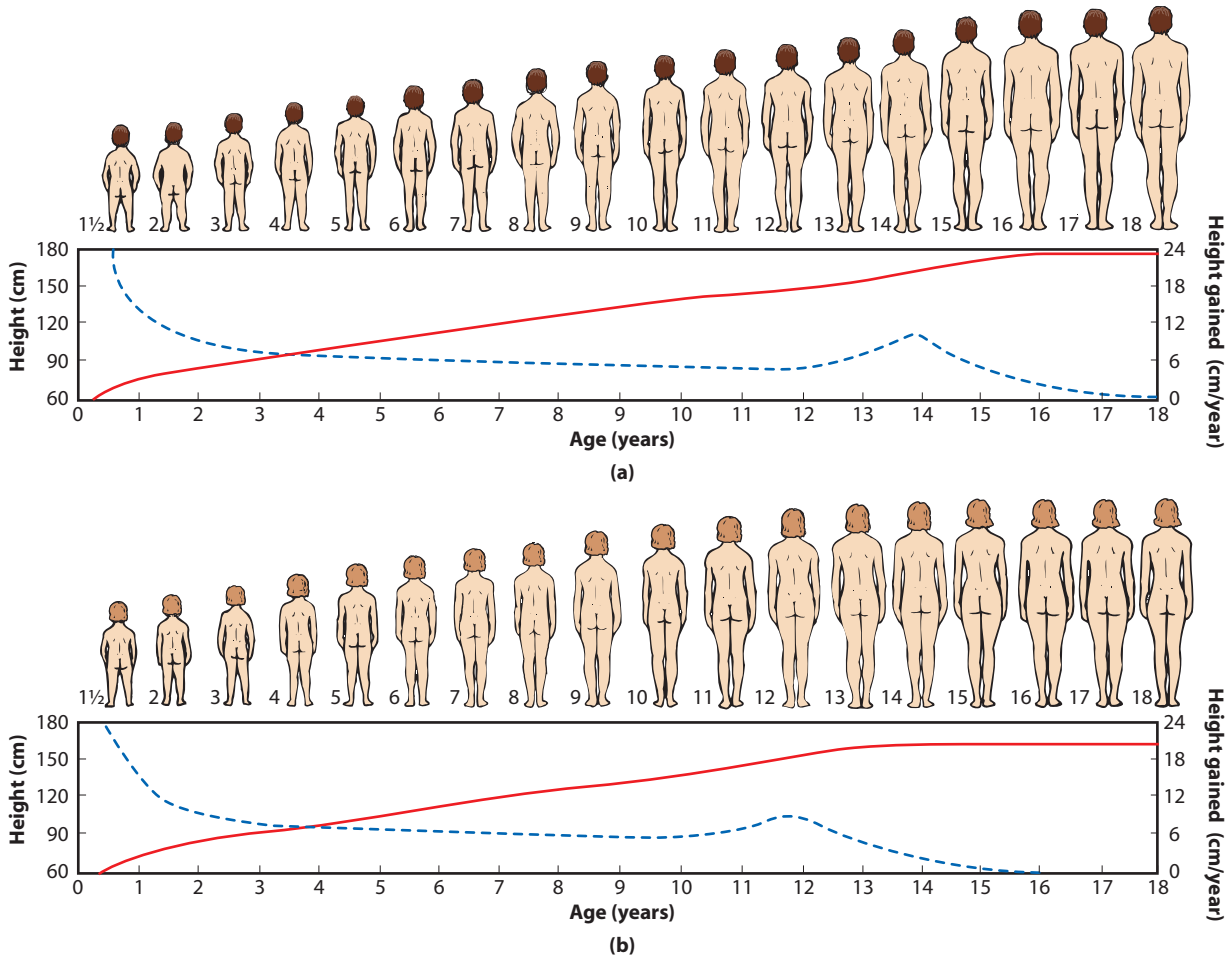

Figure 13.12 Average height (solid line) and annual height gained (dotted line) at various ages for males **(a)** and females **(b)**

3. The **gross to specific** pattern, or development of larger muscle movements before finer muscle movements. The earliest movements a child makes involve the whole body or large parts of it; these movements are referred to as gross activity because large groups of muscles are involved. As development proceeds, fine movements become possible and specific activities can be achieved, such as picking up an object between the thumb and fingers (Fig. 13.14). Another example is walking, which is initially accompanied by excessive bodily movement; as control of the appropriate muscle groups is mastered, movements become more precise.

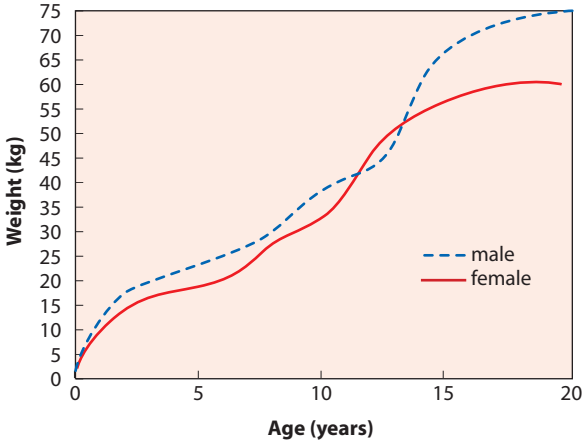

Figure 13.13 Average weight for males and females at various ages

The manipulation of an object, as illustrated in Figure 13.14, is a good example of the developmental trends. At first the baby is only able to follow the object with its eyes, then at about 20 weeks of age it is able to reach out for it. This is a rather awkward movement, mainly involving muscles attached to the shoulder and elbow. As the child gets older, the approach becomes more direct and involves wrist and hand action. The initial grasping of the object takes place at about 5 months, although it is more a squeeze with the palm than a grasp. By 7 months the palm closes smoothly

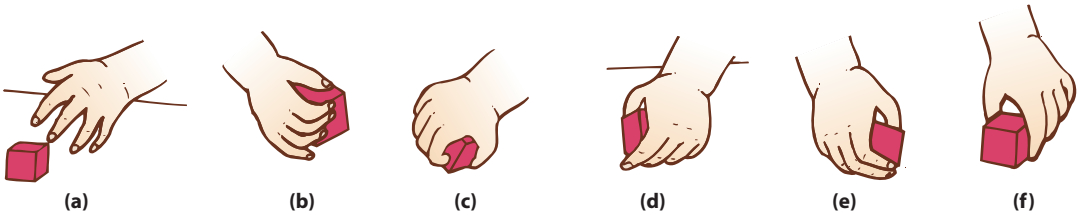

Figure 13.14 The development of grasping: **(a)** the 4-month-old infant makes no real contact with the object, but by 5 months **(b)** can touch and squeeze things; **(c)**, **(d)** and **(e)** show how the fingers and thumb gradually start to function together, until at **(f)** 12 months the thumb and forefinger can be used with some precision

around the object without the use of fingers and thumb. At about 9 months the fingers become involved in grasping, and at about 12 months the fingers and thumb start to function together.

Social development

Social development results in the infant learning to behave in a manner that is accepted by other people. This process is often called **socialisation**. To become socialised, children must begin to learn what the approved behaviours for their group are, and to model their own behaviour along the approved lines. Parents play a major role—especially in the preschool years—in the socialisation process.

At birth, babies have no interest in people. All they want is for their bodily needs to be met. For the first month or two they cannot differentiate between people, or between people and objects. At about the third month they begin to tell the difference and to respond accordingly. They start to smile in response to smiles or sounds, and express pleasure in other people's company by smiling, kicking and waving their hands. These **social smiles** in response to people mark the beginning of social development.

The mother is the most important influence on the young child's social development but all family members are important in the socialisation process. If the overall home environment favours the development of acceptable social behaviours, the chances are that children will become social people readily accepted in wider society.

Adolescence

As a child enters its second decade of life a number of physical, social and sexual changes begin to occur. The changes that take place during this period result in the child taking on the form and behaviour of an adult. This period of transition from childhood to adulthood is referred to as **adolescence**, or as the time of 'growing up'. The first phase of adolescence is puberty. **Puberty** is the time during which a person develops sexual maturity. At the end of puberty a person has the capacity to reproduce.

Although the ages at which children enter puberty are highly variable, the sequence of events that takes place is fairly constant. The changes occurring are both physical and psychological.

Physical changes at adolescence

The relatively constant rate of growth during childhood changes from about the age of 10 or 11 onwards, and is referred to as the **adolescent growth spurt**. It results in a rapid increase in height and weight (Figs 13.12 and 13.13). In most females this growth spurt occurs earlier than in most males.

The increase in growth rate that occurs during adolescence varies considerably from one person to another. The intensity, time of commencement and duration are all highly variable, so that young people in their early teens show a wide range of physical shapes and sizes.

Females start their growth spurt about two years earlier than males, usually between their eleventh and fourteenth years, but their rate of height gain is usually not as great as in males. The average male begins his growth spurt between the thirteenth and sixteenth year, and growth of up to 10 cm a year may occur. The longer period of growth for males before the commencement of their growth spurt results in most males being taller than most females by the end of the growth period. Table 13.1 shows the increases in height and weight that may be expected for each sex as a result of the adolescent growth spurt. It can be seen from the table that there is considerable variation between individuals.

Along with the increase in height and weight during early adolescence, changes to internal organs take place. The heart grows, almost doubling in size, and total blood volume increases. The lungs increase in size and capacity, enabling the adolescent to breathe more deeply and more slowly. These increases to heart and lungs give the adolescent much greater physical endurance, and contribute to a marked improvement in sporting prowess.

Changes to the reproductive system also occur at this time. In males, there is an increase in the size of the testes and scrotum. This increase usually occurs some months before the growth spurt. About a year after the testes begin to grow, the penis begins to lengthen and thicken. Around this time, pigmented pubic hair becomes noticeable. In females, the commencement of breast development is the first clear indication that changes to the reproductive system are taking place. The ovaries, uterus and vagina begin to grow at about the same time, and the vaginal lining starts to thicken. Associated with these changes is the first appearance of pubic hair.

Transition to independence

The time taken to acquire the necessary skills and techniques for life in modern society has increased as societies have become more complex. In most populations this has resulted in a large group of young people who, although physically mature, are still several years away from being accepted as adult members of society. During this period of transition, the adolescent has to emerge from dependence on the family and take on the frustrations, trauma and responsibilities of adult life. In modern society, the attainment of physical maturity has become separated from the acquisition of responsibility. Many adolescents want economic and social independence without the accompanying responsibility, which often leads to conflict between the adolescent and his or her parents.

Table 13.1 Body growth at adolescence

	Males	Females
Age of adolescent growth spurt	13–16 years	11–14 years
Height gain:		
Average	20 cm	14 cm
Range	10–30 cm	8–22 cm
Weight gain:		
Average	18 kg	15 kg
Range	6.5–30 kg	5–28 kg

Most adolescents value the support of others of their own age—their peers. This helps them to achieve some independence from the family by providing support while the adolescent tries to establish a place in society. Dependence on peer groups gradually increases, and being accepted by peers becomes extremely important. This often results in an adolescent placing greater importance on getting along with others, and being popular and friendly, than on being a good student or successful at work. This, in turn, can create further conflict with parents.

Adolescence has always been a time of learning adult roles and achieving independence. This is probably more true now than ever before: as life becomes increasingly complex and sophisticated, more skills have to be learned in order to become economically independent and self-reliant. Adolescence is therefore a period of trial through which everyone must pass. (If you are still at that stage of life yourself, remember that you are not alone!)

EXTENSION

In the 1830s the average age of a female's first menstruation was 17. Now, in Australia, it is 12. A similar trend of decreasing age of puberty is evident in males.

Find out:

- the reasons that researchers have suggested for the decreasing age of puberty in both females and males
- the social problems that are arising through males and females reaching physical maturity at an earlier age.

Working scientifically

Activity 13.1 Being born

Imagine that you are a baby that has just left the warm, snug home in which you developed for the past nine months. Write a report describing your travels from the uterus, through the birth canal and out into the world. Use correct scientific terminology to describe the changes that occur around and within you as you make the transition to independence.

Activity 13.2 Changes in hospital birth procedures

If you have a friend or acquaintance who has recently had a baby, ask her to describe the physical surroundings in the hospital and the care she received before, during and after the birth. Then, if possible, ask your mother and/or your grandmother to relate their experiences. Compile a list of changes that have taken place in maternity wards of hospitals and in the care of mother and child.

Alternatively, you could research the history of childbirth, comparing the practices of the nineteenth century with today.

Whatever your choice for this activity, be prepared to present your findings to the class.

Activity 13.3 Age, sex and development

What to do

Draw up a table in which to record the age, sex, height and weight of about 30 students. With the permission of a teacher and the cooperation of a Year 7 or 8 class, measure the height and weight of each class member. Record these figures in your table along with the sex and age in years and months for each member (which you can determine from the date of birth).

Studying your data

1. Decide on an appropriate way to group your data so that you can calculate average heights and weights in age groups.
2. If you have data for both males and females, draw graphs of average height and weight against age for each sex. Draw your graphs in such a way that you can easily compare the sexes.
3. What physical differences are there between the male and female members of the class you surveyed?
4. Are there any patterns of development that appear to be related to age?
5. Compare your data with the data for height and weight shown in Figures 13.12 and 13.13. Are your data similar to those presented in the text?
6. If possible, you could compare the heights and weights of students in Year 6, 7, 8 and 9 classes. You may then be able to estimate when the adolescent growth spurt occurs (on average) for females and males in your school.

REVIEW QUESTIONS

1. **(a)** Distinguish between gestation and parturition.
   (b) What are labour pains?
2. Briefly describe the events that take place during:
   (a) the first stage of labour
   (b) the second stage of labour
   (c) the third stage of labour.
3. Explain what is meant by the following terms:
   (a) cervical dilation
   (b) vernix
   (c) afterbirth
   (d) umbilicus.
4. Describe the changes that take place in the baby's circulatory system at birth. In doing so, ensure that you explain clearly the role of the ductus arteriosus, foramen ovale, ductus venosus and umbilical blood vessels in the foetal circulation.
5. Briefly describe the stimuli that normally trigger the newborn's first breath.
6. **(a)** Explain what is meant by the term 'puerperium'.
   (b) Why is fluid lost from the vagina for some weeks after birth?
   (c) Describe the changes a woman undergoes following delivery of her child.
7. List the main needs of the newborn infant. How are these needs met?
8. Using a diagram to illustrate your answer, describe the structure of a mature breast.
9. **(a)** Define lactation.
   (b) What is colostrum?

10. What is the milk let-down reflex? Describe the events that occur to enable milk to be released from the nipples.
11. Describe the changes that take place in body proportions over the first five years of life, with special reference to:
    (a) the head
    (b) the trunk
    (c) the limbs.
12. A baby's motor development is cephalocaudal, proximodistal and gross to specific. Using examples explain the meaning of these terms.
13. **(a)** Define adolescence.
    (b) Distinguish between the terms 'adolescence' and 'puberty'.
14. **(a)** When does the adolescent growth spurt commence in males? When does it commence in females?
    (b) Briefly describe the sequence of events taking place during the adolescent growth spurt.

APPLY YOUR KNOWLEDGE

1. What changes take place in the uterus, cervix and vagina to allow them to function as a 'birth canal'?
2. Describe the survival advantage of having the umbilical vessels constricting before they are cut.
3. Australian doctors, in general, prefer women to have their babies in a hospital. Discuss the advantages and disadvantages of this approach compared with a homebirth.
4. Many women now like the father of their child to be present at the birth, to support them, and to be there to witness the delivery. With other members of your class, list the positive benefits of the presence of the father at the birth. Consider the benefits in relation to the mother, the newborn and to the father himself. Can you think of any disadvantages?
5. If the foramen ovale fails to close, a baby may be born with a 'hole in the heart'. Use references to determine how often this birth defect occurs. What reasons are suggested for the failure of the foramen ovale to close? How soon after birth do doctors operate to rectify this situation?
6. A newborn infant has a rapid breathing rate and a heart rate. Find out why these rates are high and for how long they last. What is the survival advantage for the infant?
7. 'Growth and development are responsible for different rates of change in body systems throughout life'. Discuss this statement with reference to the infant and the adolescent.
8. **(a)** There is a great range in sizes and shapes of the female breast but they all function in a similar manner during lactation. Which tissues are responsible for the shape of the breast, and which for milk production?
   (b) Explain how the structure of the human breast is related to its function.
9. As society has changed over the years, the gap between sexual maturity and social maturity has widened. What problems does this create for the adolescent? Suggest ways that adolescents could be catered for in society to reduce some of these problems.
10. Drawing on your own experiences, how has your peer group helped you to cope with the changes taking place during adolescence? How has it been a hindrance? Have peer group attitudes and opinions caused conflict at home?