Unit
2B

Chapter 12
Pregnancy

Figure 12.1
A pregnant woman

Unit content

Body systems
Reproductive systems are specialised for support for pregnancy and birth. Body systems differentiate, grow and develop at different rates during life from fertilisation.

Development:

- implantation and development of the placenta
- significant developments in embryonic and foetal stages
- changes to a female during pregnancy.

Reproductive technologies related to:

- infertility e.g. IVF, GIFT, donors
- conception.

The relevance of human biology to everyday life
The rate of change in human biology means that there is a range of alternative treatments available. Each treatment has its risks, ethical concerns and benefits based on individual variations and the condition being treated.

In human reproduction a sperm and an egg are brought together at fertilisation. The embryo resulting from the fertilised egg develops in the mother's uterus. When mature enough, the baby is born and begins an independent existence outside the mother's body.

This chapter focuses on the way the fertilised egg develops as it journeys down the oviduct, how implantation takes place, and how the developing offspring changes during its time in the uterus. Chapter 13 will look at birth and the development of the infant.

Development of the embryo after fertilisation

A successful pregnancy is most likely to occur if fertilisation (Fig. 12.2a) takes place when the egg is about one-third of the way along the uterine tube. The fertilised egg (or zygote) is pushed towards the uterus by muscular contractions of the uterine tube and the beating action of cilia.

Immediately following fertilisation the zygote begins to divide (known as cleavage) as it moves along the uterine tube to the uterus. During this time there is no growth, so as the cells divide they become progressively smaller until a solid ball of cells is formed (Fig. 12.2c). Cell division continues and the cells arrange themselves to form a hollow ball of cells called a **blastocyst**. The blastocyst consists of a thin layer of cells surrounding a cavity filled with fluid. At one side of the cavity is a group of cells called the **inner cell mass** (Fig. 12.2d), which eventually becomes the embryo. The blastocyst stage is reached when the embryo is in the uterus, usually about five days after fertilisation.

The blastocyst remains free within the cavity of the uterus for two to three days, and then sinks into the soft endometrium (uterine lining) to become firmly attached to the wall (Fig. 12.2e). This process is called **implantation** and enables the blastocyst to gain nourishment for growth and development by absorbing nutrients from the glands and blood vessels of the lining.

Implantation of the embryo into the lining of the uterus normally occurs naturally. Since 1977 it has been possible to mix an egg with sperm in the laboratory. The resulting embryo can then be placed in the female's uterus, where it can implant in the lining. This technique, known as **in-vitro fertilisation (IVF)**, can help couples who have been unable to achieve pregnancy by natural methods. It will be discussed in more detail later in this chapter.

Pregnancy

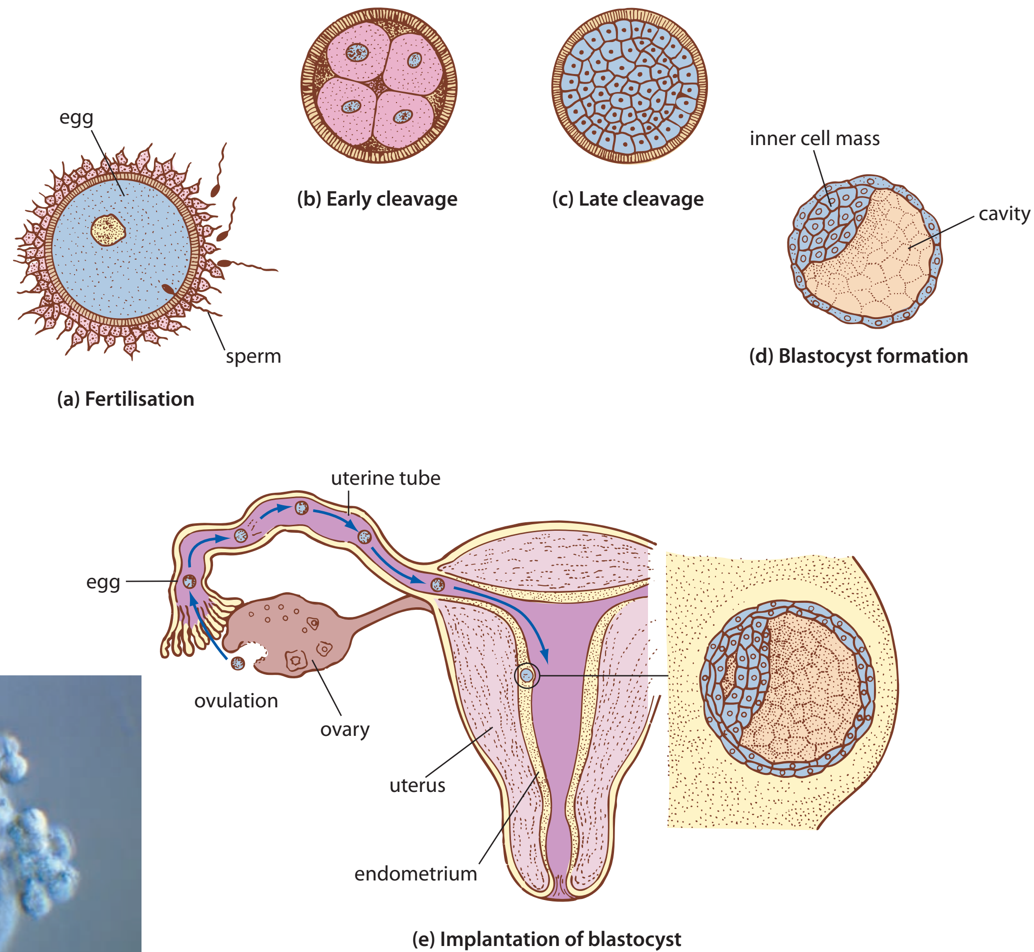
Continued development of the blastocyst depends on the endometrium being maintained. High levels of hormones in the blood stop the endometrium breaking down so that the menstrual cycle ceases. During the early stages of pregnancy it is the corpus luteum (see Figs 11.2 and 11.3) that produces these hormones until the developing placenta can take over the role of maintaining the endometrium.

The first two months of pregnancy are referred to as the embryonic period, but after the second month the developing individual is called a **foetus**. (Note: In this book, the spellings 'foetus' and 'foetal', in common use in Australia, have been adopted. In texts originating in the United Kingdom or the United States, or in specialist medical publications, you will encounter the spellings 'fetus' and 'fetal'.)

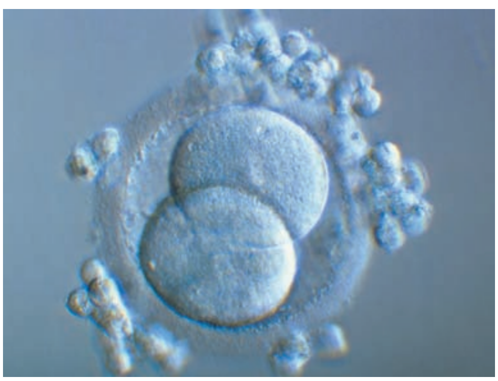
Development of the placenta

By the end of the embryonic period, membranes have developed around the foetus. Part of one of these membranes is the **placenta**, an organ that supplies nutrients to,

Figure 12.2 **(a)** to **(e)** Fertilisation, cell division and implantation (the arrows in (e) indicate the path of the egg before and after fertilisation); **(f)** photograph of human embryo at the two-cell stage. In this photograph the embryo is still surrounded by the gelatinous covering that was around the egg



(f)



and removes wastes from, the foetus. The placenta is a combination of foetal and maternal tissues. By the end of the third month it is completely formed. The placenta also serves as an endocrine organ, producing a number of the hormones necessary to maintain pregnancy. Table 12.1 lists its various functions.

The foetal part of the placenta begins to develop as the blastocyst is implanted in the endometrium. Small, branching, finger-like projections develop from the outer

Table 12.1 Functions of the placenta

Role	Function
Endocrine	Secretes a number of hormones necessary for maintaining the pregnancy
Excretory	Transports nitrogenous wastes such as urea, uric acid, ammonia and creatinine from the foetal blood to the mother's blood supply for excretion by the mother's kidneys
Immune	Transports antibodies from the mother into the foetal blood supply so that the foetus has immunity to some infectious diseases
Nutritional	Transports nutrients such as glucose, amino acids, fatty acids, vitamins and minerals from the mother's blood to the foetal blood; stores some essential nutrients early in pregnancy and releases them later when the demand is greater
Respiratory	Transports oxygen from the mother to the foetus, and carbon dioxide from the foetus to the mother

layer of cells (Fig. 12.3). These projections, in which numerous blood vessels develop, are called **chorionic villi**. They grow into the endometrium, much like the root of a tree penetrating the soil. As the villi penetrate the endometrium, they become surrounded by pools of the mother's blood, which has collected in spaces within the endometrium (Fig. 12.4). In this way the villi are bathed in the mother's blood; however, the foetal and maternal blood do not normally mix because a few layers of cells separate the two blood supplies. The exchange of materials takes place by diffusion and active transport. Oxygen and nutrients from the mother's blood diffuse into the foetal blood, and wastes leave the foetus by diffusing into the maternal blood. The large number of villi that form provides an extensive surface area across which substances can pass. A fully developed placenta has an estimated surface area of about 16 m^2.

The placenta is attached to the foetus by the **umbilical cord**. Inside the umbilical cord are two **umbilical arteries**, which carry blood to the capillaries of the chorionic

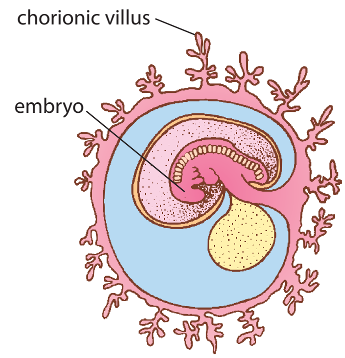
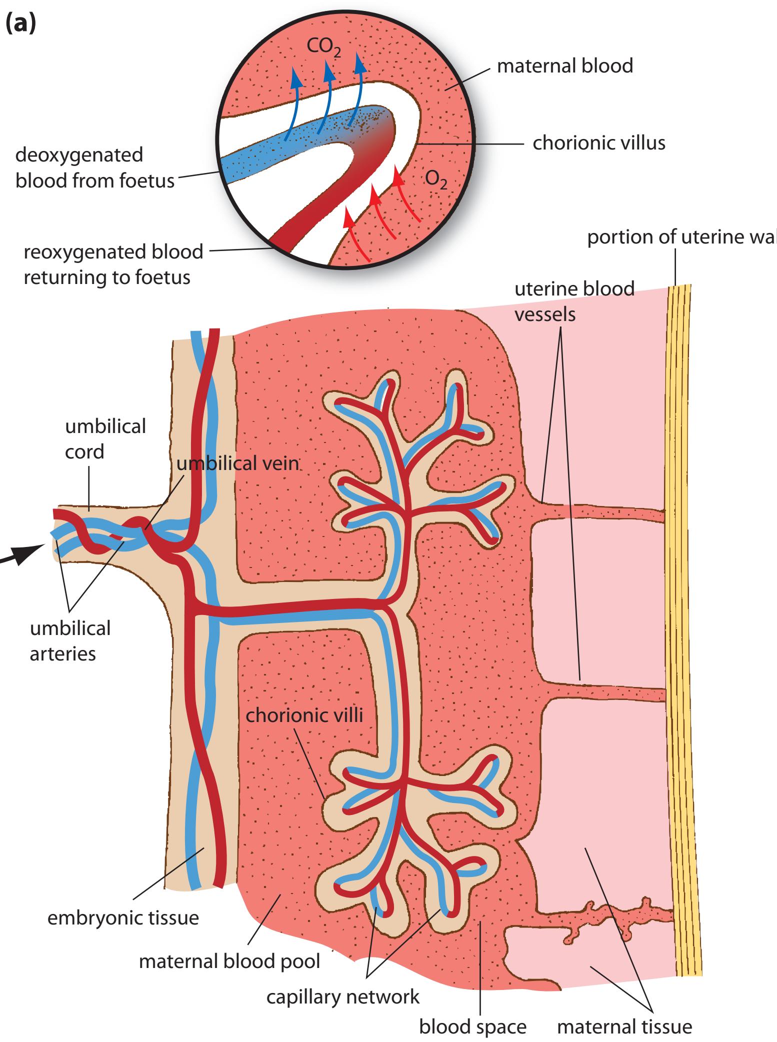


Figure 12.3 Chorionic villi

Figure 12.4 **(a)** Structure of the placenta and umbilical cord; **(b)** a human placenta—note the large blood vessels on the surface

(a)



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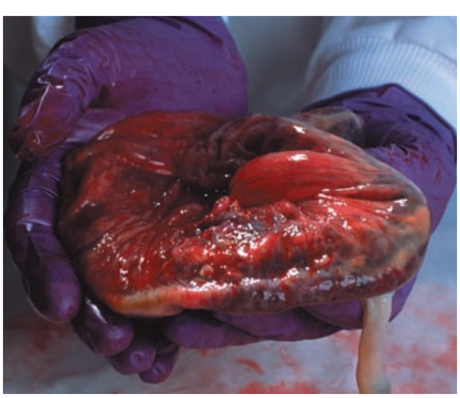


villi. A single **umbilical vein** carries blood from the placenta, through the umbilical cord, back to the foetus. On the maternal side, blood from the mother enters the placenta through the uterine arteries, flows through the blood spaces where the exchange of substances occurs, and leaves again through the uterine veins (Fig. 12.4).

EXTENSION

The corpus luteum and the placenta both have a role in the secretion of hormones to maintain pregnancy.

- Find out the names of the hormones involved.
- Describe the role of each of these hormones in the maintenance of pregnancy.

Embryonic development

Primary germ layers

Once the embryo has reached the uterus and becomes enclosed in the endometrium (the uterine lining) the inner cell mass of the blastocyst undergoes changes (Fig. 12.5). This results in the formation of three layers of cells, the **primary germ layers**. These layers, called the **ectoderm**, **mesoderm** and **endoderm** (Fig. 12.5d), are the embryonic tissues that will differentiate into all the tissues and organs of the body. **Differentiation** is the development of cells with specialised structures and functions and will be discussed in more detail in Chapter 14.

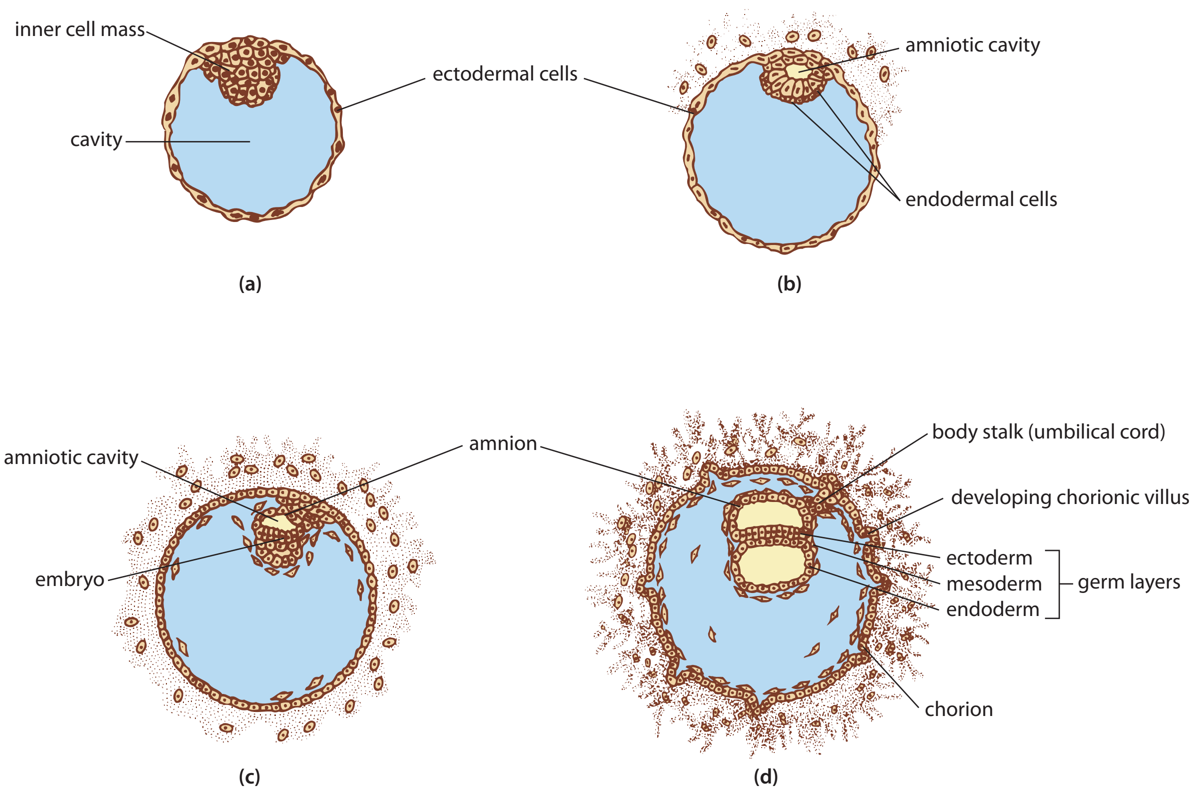


Figure 12.5 Formation of amnion, chorion and germ layers

Embryonic membranes

Early in the embryonic period, four embryonic membranes form. These lie outside the embryo and serve to protect and nourish it as it develops.

The **amnion** is the first membrane to develop. By the eighth day after fertilisation it surrounds the embryo, enclosing a cavity into which it secretes **amniotic fluid**. This fluid serves to protect the embryo against physical injury by acting as a shock absorber. It also helps to maintain a constant temperature and allows the developing embryo—and later the foetus—to move freely. The amnion expands as growth takes place (Fig. 12.6). It usually ruptures just before childbirth, releasing the amniotic fluid, an event commonly referred to as 'breaking of the waters'.

Another embryonic membrane is the **chorion**. It is formed from the outer cells of the blastocyst together with a layer of mesodermal cells (Fig. 12.6c and 12.6d). The chorion surrounds the embryo and the other three embryonic membranes. As the amnion enlarges it fuses with the inner layer of the chorion. Eventually the chorion becomes the main part of the foetal portion of the placenta.

In addition to the chorion and the amnion there are two other membranes, but these are not as important in humans as they are in the development of many other animals (Fig. 12.6). They become part of the umbilical cord.

Continued development of the embryo

After one month of growth the human embryo is just under 4 mm long. The most obvious feature at this stage is the development of muscle segments on either side of

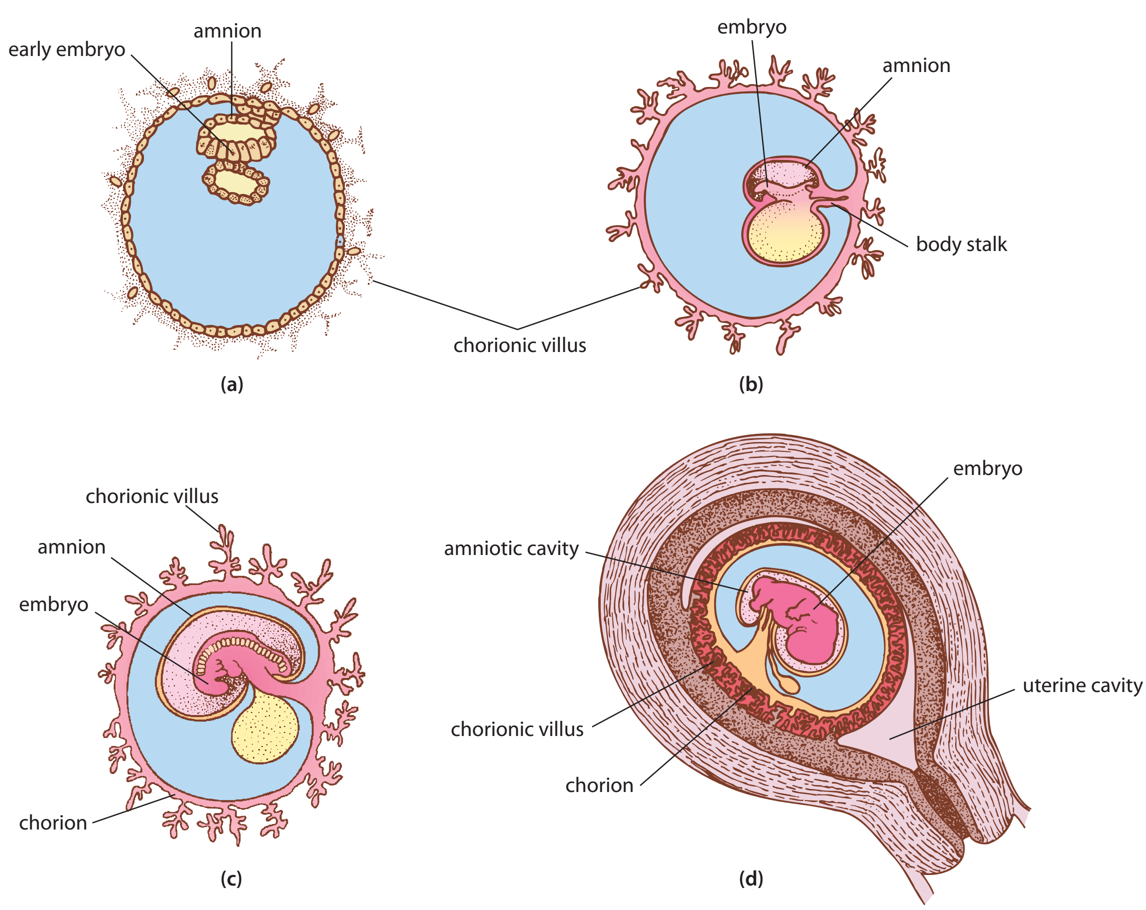


Figure 12.6 Development of the embryonic membranes

the tube that are to become the brain and spinal cord. These blocks of mesodermal tissue increase in number over time. By the end of the fourth week there are 30 pairs of them, representing the beginnings of the muscles and the vertebrae of the spinal column. In addition, the brain is beginning to form, a tail is evident, and the heart and liver are beginning to develop (Fig. 12.7).

The throat region contains a number of pharyngeal arches with clefts between them. As development proceeds these arches will form the structural elements of the face and throat, and the pouches that develop in the clefts will give rise to the epithelial linings and glands associated with the throat.

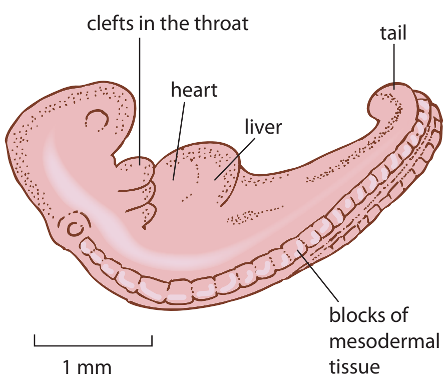


Figure 12.7 Embryo at the end of the fourth week

During the fifth week the arm and leg buds start to appear (Fig. 12.8a). The arm buds are slightly more advanced, but both elongate rapidly from this time on. By the end of the embryonic period (week 8) the embryo has a recognisably human form and all organs are present, although many are not fully functional. It has undergone considerable growth from a microscopic cell to being 3 cm in length from the top of its enlarged head to its buttocks, and weighing about 1 g. The head is almost half the size of the embryo (Fig. 12.9) and the eyes appear like slits, having moved from the sides of the head to be directed forward. The jaws are almost fully developed, as is the nose, and there are small earlobes. The arms and legs are well proportioned, and the hands are formed with distinctly human fingers. Similarly, the toes are well formed, and the external sexual organs are evident, so that the embryo is clearly male or female.

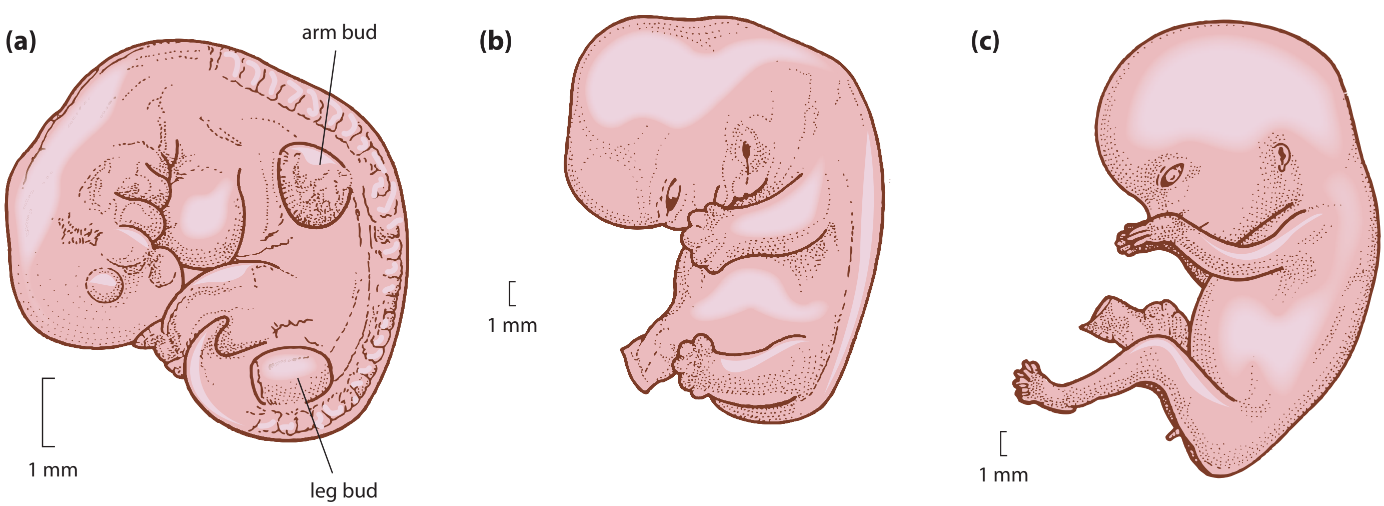


Figure 12.8 Embryo at the: **(a)** beginning of the fifth week; **(b)** middle of the sixth week; and **(c)** end of the seventh week

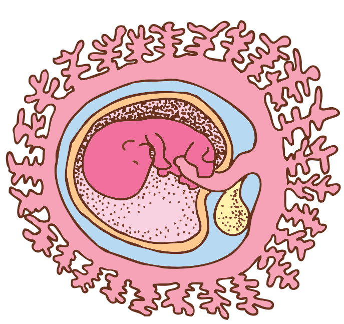


Figure 12.9 An eight-week-old embryo

Foetal development

During the first two months of embryonic life the general external features and body form of the infant develop. The basic plan of the organ systems is in place, and from this stage onwards the term **foetus** is used to describe the developing individual. The foetal period, from the ninth week through to birth, is characterised by a great increase in size and by the maturation of the organ systems (Table 12.2). The length of the foetus from the crown of the head to the buttocks grows from about 3 cm to 50 cm, and the weight increases from about 4 to over 3000 g. The proportions of the body change gradually, with the head becoming proportionately smaller and the limbs longer. Between weeks 9 and 12 the foetus doubles in length. The developing

Table 12.2 Stages of foetal development

Age (in months)	Foetal development
3	Forelimbs well developed; eyelids closed; outer ear completed; bone marrow formed; blood cells formed in bone marrow; sex distinguishable
4	Arms and hands fully shaped; skeleton completed; exercising of muscles evident; ears stand out from head
5	Fine hair covers body; gripping reflexes are developed; increased growth
6	Respiratory movements; digestive glands begin to function; tooth buds evident; eyebrows and eyelashes
7	Period of greatest growth; all systems functional except respiratory system
8	Accumulation of fat beneath skin; growth slowed
9	Eyes open; nose well formed; sucking and grasping reflexes apparent; fine body hair is shed

body straightens so that the head no longer bends forward, and the posture is more upright. Fingernails, toenails and hair appear. The mother can detect her enlarging uterus at this stage.

During the fourth month the uterus expands and the woman's abdomen begins to bulge. The foetus grows rapidly during this month to become about 18 cm long and 100 g in weight. Posture is more erect, fingerprints appear and the foetus moves, stretching its arms and legs. The mother may begin to detect these movements. The heart beats strongly at 120–160 beats per minute, twice the rate of the mother's heart.

By week 20, the end of the fifth month, the foetus is about 25 cm long and weighs about 300 g (Fig. 12.10). Foetal movements, such as kicking and turning, can now be felt clearly by the mother.

After 24 weeks of development, the mother is showing obvious signs of pregnancy (Fig. 12.11). The foetus has grown to about 27–35 cm in length and weighs between 565 and 680 g. By the end of week 28 it is about 38 cm in length, weighs over 1000 g, and moves around vigorously within the uterus. The brain has enlarged considerably, its surface now furrowed with developed functional areas. In the male, the testes usually descend into the scrotum during this period.

By the end of week 32 the foetus is between 41 and 45 cm in length and weighs between 1800 and 2200 g. By week 40 the pregnancy is at full term. The foetal activity evident in earlier weeks is now diminished, as the foetus occupies all the available space within the uterus—it simply has no room to move. By this stage the foetus is about 50 cm in length and weighs about 3300 g. Boys are usually a little heavier—by about 100 g—than girls. However, the birth weight of a baby can vary considerably, from as little as 2500 to as much as 4500 g. Due to growth of the body the head is now smaller in proportion to the size of the body. The nose is well formed.

Shortly before birth the foetus changes its position in the uterus and comes to lie with its head resting inside the curved shape of the pelvis (Fig. 12.11e). The movements of the foetus in this position are even more restricted than before. Growth of the foetus at this stage is also very slow, as the placenta begins to fail and to become more fibrous.

During the later stages of pregnancy, antibodies from the mother diffuse across the placenta into the baby's blood. These give the newborn child temporary immunity against diseases to which the mother is immune. After about six months the effects of the antibodies gradually decrease as the child begins to develop its own immune responses.

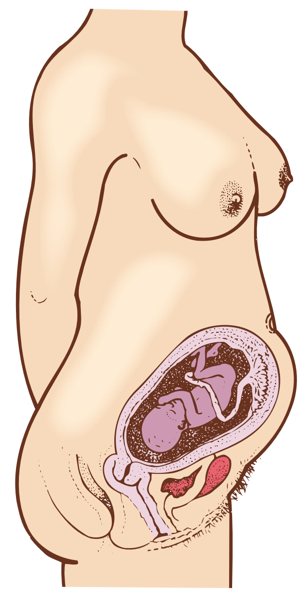


Figure 12.10 The 20-week foetus

Pictures of the embryo and foetus at various stages of development can be seen at:

- http://www.visembryo.com/baby
- http://embryo.soad.umich.edu/carnStages/carnStages.html

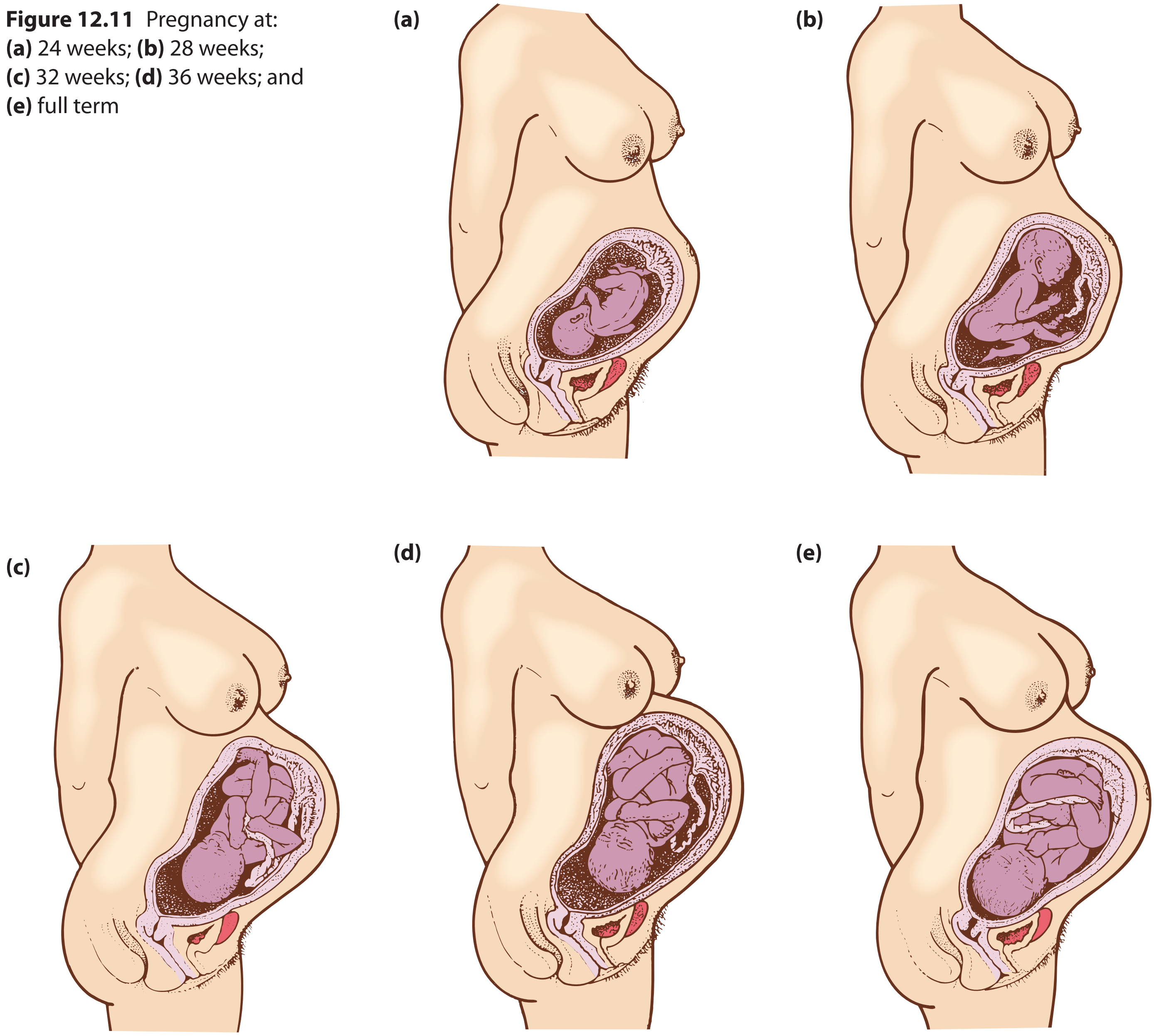


Figure 12.11 Pregnancy at: **(a)** 24 weeks; **(b)** 28 weeks; **(c)** 32 weeks; **(d)** 36 weeks; and **(e)** full term

The pregnant mother

During pregnancy the baby grows remarkably. It needs to be supplied with oxygen and nutrients. It needs to have carbon dioxide and other wastes removed. After birth, continued nourishment is required. Changes in the mother during pregnancy accommodate all of these requirements.

The most obvious changes to the pregnant woman are those associated with her growing abdomen: the abdomen bulges as a result of the growth of the uterus. Figure 12.12 shows the outline of the uterus at various stages after implantation. Not all the increase in the size of the abdomen is due to the uterus. Some is due to other internal organs, such as the stomach, liver and intestines, being forced upwards and outwards (Fig. 12.13).

Another obvious change during the course of pregnancy is the enlargement of the breasts. The hormones of pregnancy result in the development of the milk-secreting tissues, which leads to an increase in size.

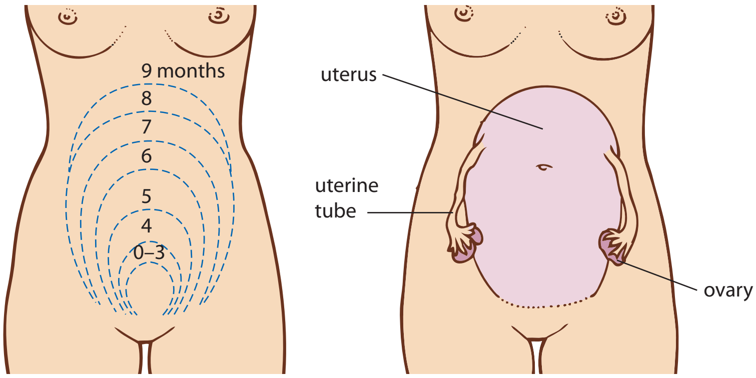
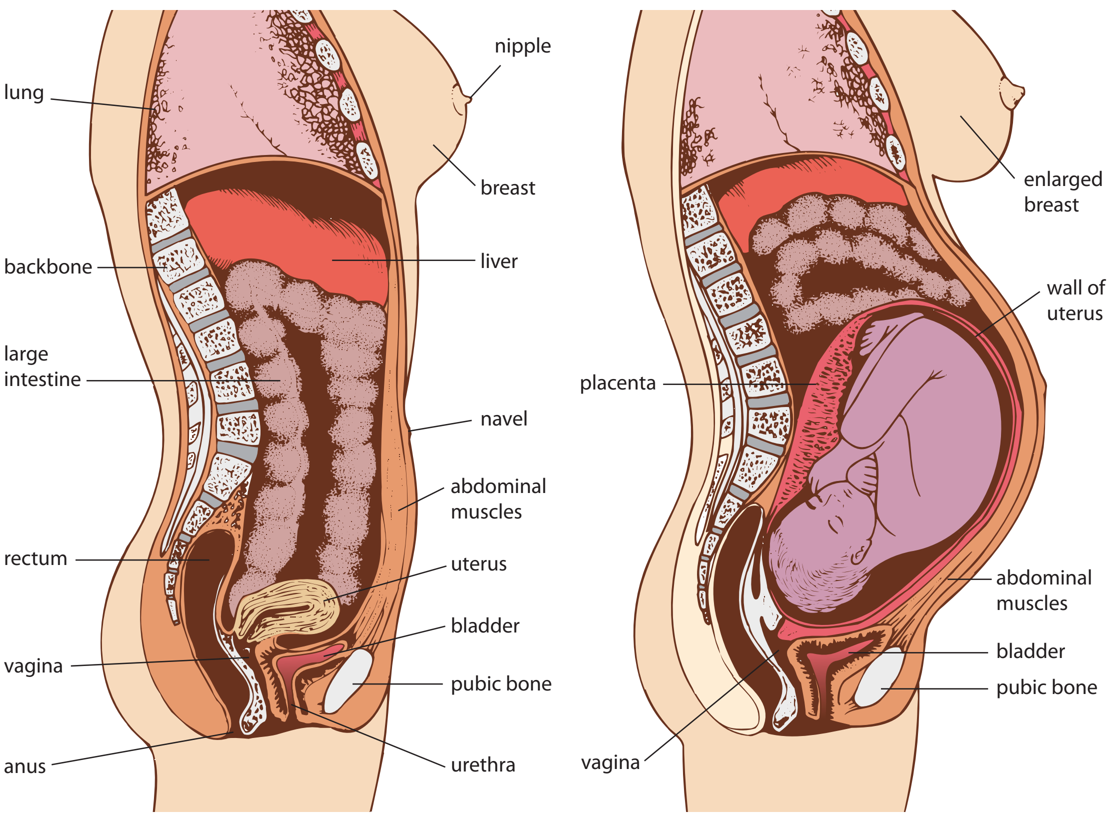


Figure 12.12 Size and position of the uterus at various stages of pregnancy



(a) (b)

Figure 12.13 Comparison of the internal organs of **(a)** a woman who is not pregnant and **(b)** one who is

Pregnancy also affects the mother in less obvious ways. There is an increase in the size of the heart and an increase in blood volume. This is to cater for the extra blood that is flowing through the placenta. It also results in an increased blood flow to the kidneys and increased urine production. Pressure on the bladder causes an increase in the frequency of passing urine. During the first three months of pregnancy the expanding uterus presses on the bladder so that it feels as if it is filled with urine. As the uterus grows it moves up the pelvic cavity, releasing this pressure. Then, during the last stages of pregnancy, the foetus presses on the bladder (Fig. 12.13).

Pregnancy can also affect the emotional state of the mother. Changes in mood may be due to the changes in hormonal balance but may also be the result of natural fears accompanying pregnancy. The mother may be concerned about her child's development, the problems that may occur at the time of birth, and the effect the newborn child will have on the rest of the family. Many of these factors are beyond the control of the pregnant woman and so support and reassurance from family and friends are very important in maintaining a positive outlook.

Treatment of infertility

Some couples are unable to achieve a pregnancy. Physical defects may stop the sperm and egg from uniting, or the man may produce too few sperm to fertilise the egg.

Microsurgery can be used to solve some problems of infertility. Blocked oviducts and sperm ducts can be opened and tumours can be removed. In other cases, cervical mucus hostile to sperm may have to be treated.

Artificial insemination by donor

If the man's sperm are unable to fertilise the egg, a couple may decide to have a child through semen donated by another man. This procedure, known as **artificial insemination by donor (AID)**, is becoming increasingly common and the pregnancy rate is high. Between 70% and 80% of couples using AID eventually have a child by this method.

The major risk in the use of AID arises from the possible transmission of disease from the donor to the recipient. For this reason all donors are carefully screened for sexually transmitted infections and genetic diseases, mental problems and general health. As far as possible the physical characteristics of the donor are matched to those of the sterile man. In most cases, the donor is never seen or known by the couple, and the donor does not know to whom his sperm has been given.

About the time that ovulation is expected, the woman visits her doctor and, on each day for three or four successive days, the donor's semen is injected into her upper vagina. It is unusual for pregnancy to occur the first time that AID is used. On average, three inseminations a month for a period of three months are necessary.

Assisted reproductive technologies

About 30 years ago, in an experimental procedure called **in-vitro fertilisation (IVF)**, a man's sperm was used to fertilise a woman's egg in a glass dish in a laboratory. For the first time, fertilisation had occurred outside a woman's body. The embryo was then implanted into the woman's uterus and, nine months later, on 25 July 1978, the first 'test tube baby' was born.

Since that time, **assisted reproductive technology (ART)** has been the subject of intense research in Australia as infertile couples try to achieve parenthood. ART refers not only to IVF but also to variations that have been developed to improve the chance of having a child. One variation is **gamete intrafallopian transfer (GIFT)** where the eggs and sperm are mixed together immediately after the eggs have been collected. The mixture is then injected into the woman's uterine tubes (Fig. 12.15). This procedure allows the eggs and sperm to mix naturally and, it is hoped, to fertilise. Any fertilised eggs then pass down the uterine tube to the uterus in the usual way.

Most of the techniques require the woman to take a fertility drug to increase the number of eggs produced and released by the ovaries. The eggs can then be harvested at ovulation and mixed with sperm (Fig. 12.14). Variations in the techniques relate to when and where the egg–sperm mixture, or the embryo, are placed into the woman's reproductive system.

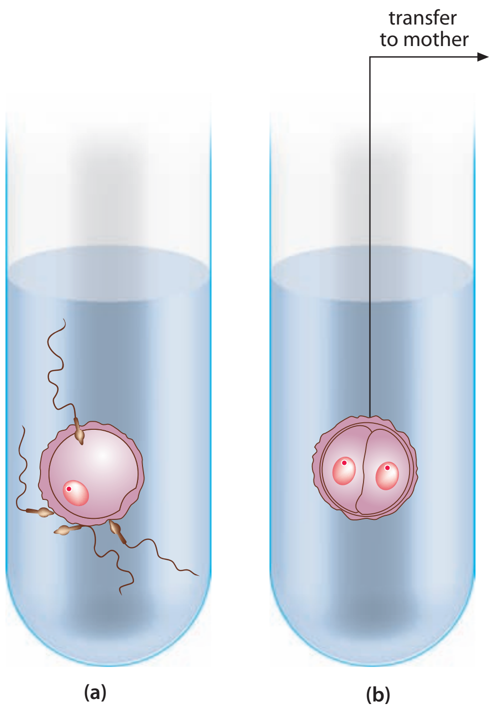


Figure 12.14 In-vitro fertilisation.
(a) Sperm are added to an egg kept in a nutrient medium at body temperature.
(b) After fertilisation the dividing cells are transferred to the mother

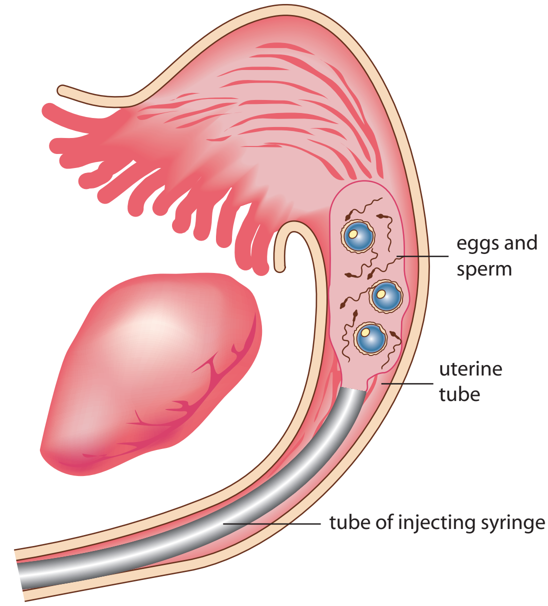


Figure 12.15 Eggs and sperm being released into the uterine tube where fertilisation may take place

Because of the chances of failure, most of these procedures require a number of eggs. This often means that more embryos are available than are required for implantation into the female's uterus. The excess embryos are frozen for later use in case a successful pregnancy does not eventuate. If they are not needed, many ethical and moral questions are raised. At some time, a decision must be made about what is to happen to the unused embryos, as they cannot be stored forever.

Currently in Australia, frozen embryos are stored for five years, and a study presented in late 2007 reported that over 118 000 frozen embryos were in storage in Australia. What should be done with these embryos, each with the potential to develop into a human? Parents are asked if they would like them thawed and implanted, or if they would donate them to others unable to produce an embryo of their own. Other alternatives are thawing and disposal, or use in scientific research. Research on human embryos is highly controversial, as is the donation—or even sale—of embryos. Such ethical questions need very careful consideration and society as a whole has the right to participate in deciding what courses of action should be followed. However, a resolution that is acceptable to all parties may never be reached.

If the man's sperm count is very low, or if his sperm are of insufficient quality to attempt IVF, a procedure called **intracytoplasmic sperm injection (ICSI)** may be used (Fig. 12.16). A single sperm is injected into a single egg and the resulting embryo then transplanted into the woman's uterus. Fertilisation rates of 20–30% have been achieved but concern has been expressed that the technique may increase the incidence of birth defects.

A **donor egg or embryo** is used when a woman is unable to conceive using her own eggs. An egg donated by another woman is mixed with her partner's sperm and

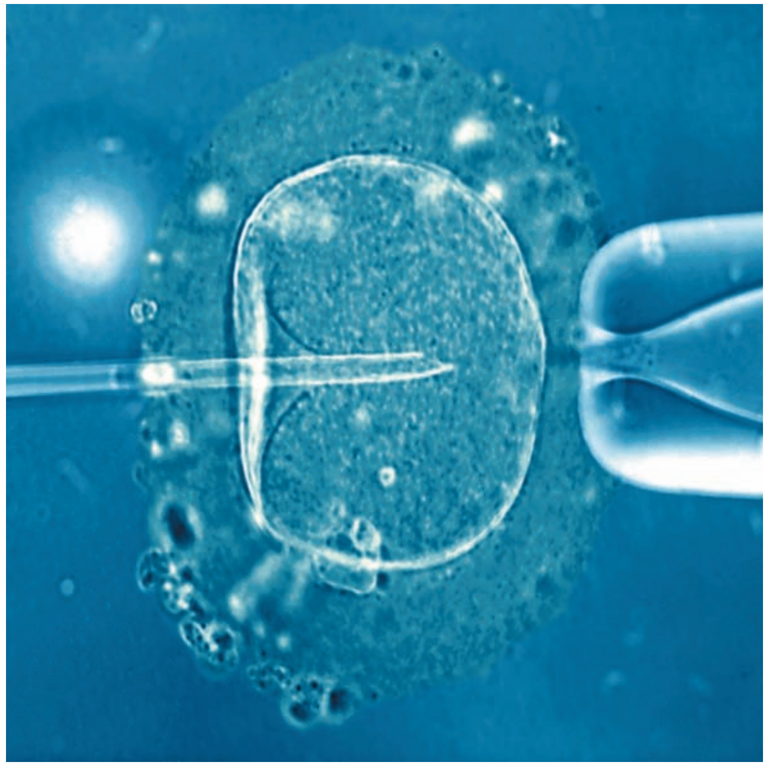


Figure 12.16 Intracytoplasmic sperm injection. The photograph shows a sperm being injected into an egg

the resulting embryo is implanted into her uterus. This procedure is also able to be done using a donated embryo.

Sometimes a woman may agree to bear a child for a couple when the female partner is unable to become pregnant, a situation called **surrogacy**. In these situations, the man provides semen either naturally or through artificial insemination. The surrogate mother agrees to give the child to the couple who have asked (and usually paid) for her help. In some cases the surrogate mother, after giving birth, has decided to keep the child, causing great emotional and legal problems for both parties.

With ART it has become possible for eggs and sperm from a couple unable to have children to be implanted into a surrogate mother. The surrogate then goes through the pregnancy and gives the baby to the genetic parents after it has been born.

EXTENSION

Many people who wish to have a family are unable to do so.
Find out:

- about the causes of infertility in both males and females
- what can be done to help infertile people.

When does human life begin?

A new life begins when an egg is fertilised by a sperm. When should we regard that new life as human? This is a question about which there is much disagreement in our society.

Many people argue that human life begins at the moment of fertilisation. The fertilised egg, or zygote, has a unique set of DNA and has all of the requirements necessary to develop into a human person.

Others say that the embryo cannot be regarded as human until it is implanted into the lining of the mother's uterus. Unless implantation occurs the embryo cannot develop any further.

Another commonly held view is that the developing child becomes a human person when it looks like a miniature human being. This occurs about the end of the second month of pregnancy and, from that time on, the embryo is referred to as a foetus.

Yet another argument is that the foetus becomes human during the fifth month of pregnancy. This is when activity begins in the cerebral cortex of the developing brain. We cannot know whether the foetus is aware of its surroundings or whether it can feel pain, but during the fifth month the brain develops to the point where such processes could be possible.

These arguments have particular relevance to the questions of abortion, the harvesting of stem cells from embryos and the disposal of surplus embryos that have been produced by IVF.

What do you think about the beginning of human life? *When* an embryo becomes a human person is a moral and ethical question. Science cannot answer such questions. Each of us must consider the evidence that scientific investigation has produced and make up our own minds about where we stand on the issue.

Working scientifically

Activity 12.1 Examination of a pregnant rat

The female reproductive systems of mammals are all very similar in that they produce eggs, receive the penis during mating, allow deposition of sperm, and provide nourishment and protection for the developing offspring. Examining a pregnant rat will therefore help you to understand pregnancy in humans.

Your teacher may ask you to dissect a rat yourself, may demonstrate the dissection, or may refer you to a video or photographs for this activity.

What you need

A pregnant female rat; dissecting board; dissecting equipment; pins; string; hand lens or magnifying glass; disposable gloves

What to do

Your teacher will demonstrate how to tie the rat firmly to the dissecting board.

1. Identify the external features of the rat that are associated with reproduction—the genital opening and the mammary glands. In addition, locate the urethra and the anus. Figure 12.17 may help with your identification.
2. Count the number of nipples on the underside of the abdomen.
3. Follow your teacher's instructions to open the body cavity to reveal the reproductive organs. There may be some fat associated with these organs. Do not try to remove it, but you may need to displace it so that the reproductive organs can be easily observed.
4. Locate the vagina.
5. Locate the two uteri that extend from the vagina up each side of the body cavity. Examine each and determine the number of foetuses that the rat was carrying.

6. Cut open part of the uterus and carefully remove a foetus. Identify the following structures—amnion, placenta and umbilical cord.
7. At the anterior (front) end of each uterus is a very short uterine tube that you will find difficult to identify.
8. Also at the end of each uterus is a small, round, orange-coloured structure. This is the ovary.
9. Identify the urinary bladder. If the rat is not preserved, this will appear as a semi-transparent bag containing clear fluid.

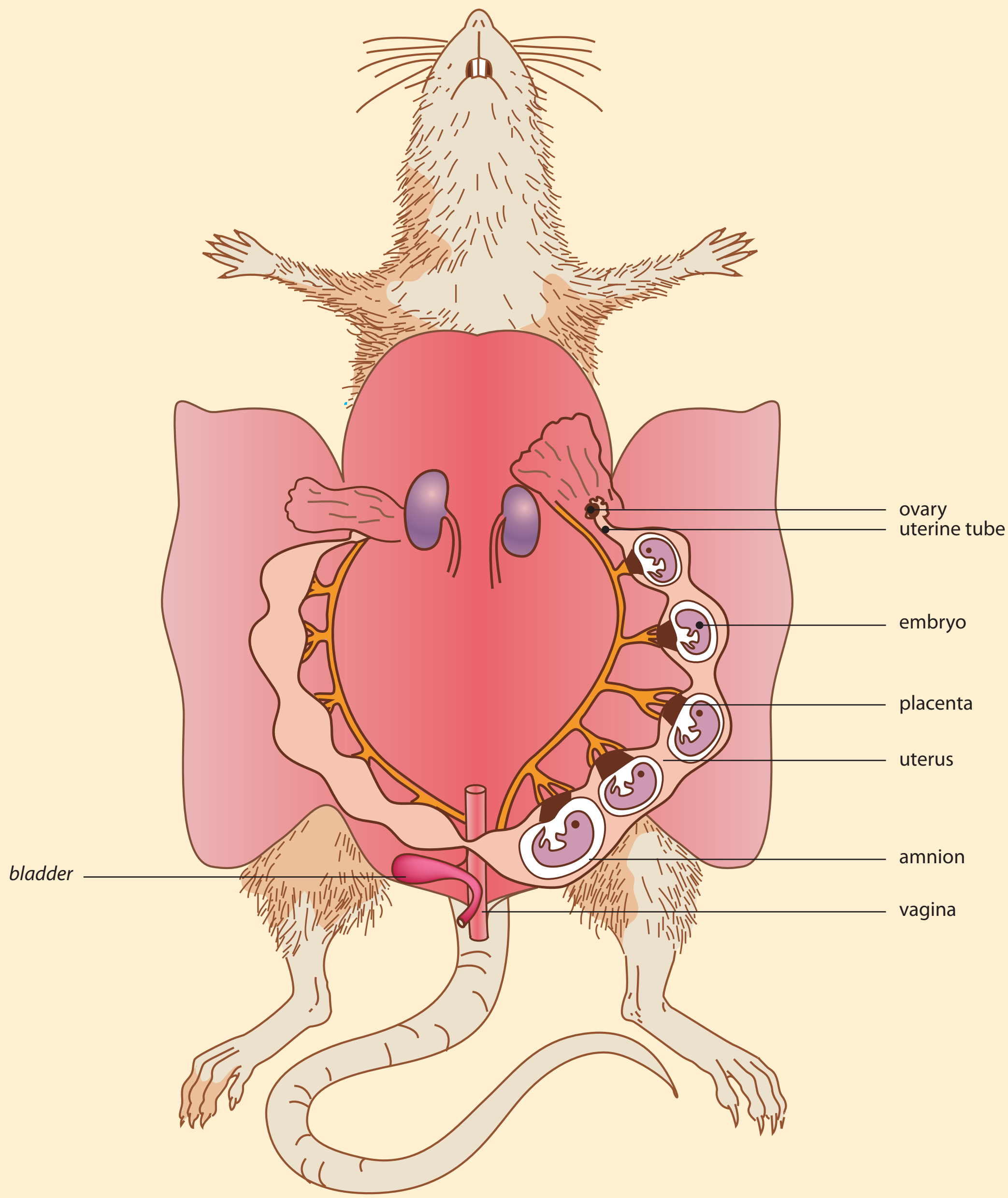


Figure 12.17 The pregnant female rat showing the reproductive system (the alimentary canal is not shown)

Studying your observations

1. Check with others in the class and ensure that you agree on the identification of the various reproductive structures.
2. Draw a diagram of your dissection, labelling all the structures you have identified.
3. How many pairs of mammary glands were present on your specimen? Were there sufficient nipples for the number of offspring being produced?
4. Describe the appearance of the placenta and umbilical cord.
5. How is the colour of the placenta related to its function?
6. Describe the appearance of the amnion and the amniotic fluid that it contained.
7. What is the purpose of the amniotic fluid?
8. Compare the female rat with the human female in Figure 12.13. List the similarities and differences between the pregnant rat and a pregnant human.

Activity 12.2 Should we use assisted reproductive technologies?

Hold a class discussion on the scientific and ethical issues involved in the use of assisted reproductive technologies such as AID and IVF in humans. Assign the roles of interested parties to some of the members of the class, who will then assume that role in the discussion. The roles could include:

- a childless couple who have been trying to start a family for several years
- a person who was born because of the use of a reproductive technology
- a doctor specialising in reproductive technology
- a member of the public opposed to the use of reproductive technologies
- a member of the clergy opposed to AID and IVF
- a scientist researching the improvement of reproductive technologies
- a member of the public worried about the morality of choosing the sex of a baby
- a person concerned about the poor success rate of IVF and the high financial cost.

As well as moral, ethical, religious and economic issues, the discussion could consider questions such as:

- Why do people's opinions differ about what should be permitted using reproductive technologies?
- How can society best consider the wide range of views that people hold on these issues?
- Who should be allowed to decide whether reproductive technologies are used?
- What are the responsibilities of the scientists who research and develop reproductive technologies?
- Who should set standards for laboratories and doctors involved in using modern reproductive technologies?
- Who has the right to decide whether a particular person or couple should be allowed to use a particular reproductive technology?
- Due to the high cost involved, should a limit be applied to the number of times a couple can use a particular procedure?

After listening to the opinions expressed during the discussions, prepare a list of arguments for and against the use of reproductive technologies, such as AID, IVF and surrogacy, in humans.

REVIEW QUESTIONS

1. (a) What is implantation?
   (b) Describe where, when and how implantation occurs.
2. (a) What is a blastocyst?
   (b) At what stage of embryonic development does a blastocyst occur?
3. What are the primary germ layers?
4. Distinguish between the terms 'embryo' and 'foetus'.
5. (a) What is the placenta?
   (b) From which of the embryonic tissues does the placenta develop?
   (c) Describe the functions performed by the placenta.
6. Describe how blood from the embryo/foetus gets to and from the placenta.
7. Briefly describe the function of the following embryonic membranes:
   (a) amnion
   (b) chorion.
8. How does amniotic fluid help the development of the foetus?
9. Describe the main features of the eight-week-old embryo.
10. List the changes that occur in the mother during pregnancy.
11. (a) Explain the procedure used in in-vitro fertilisation.
    (b) What alternatives are there for the unused embryos from IVF?
12. Explain the procedure used for AID.
13. What is meant by surrogacy?

APPLY YOUR KNOWLEDGE

1. Explain how a blastocyst can consist of many more cells than a zygote yet be only slightly larger in size.
2. Explain how the structure of the placenta is related to the functions that it performs.
3. In this chapter, the length and weight of the foetus at various times are given. Use these figures to draw a graph showing the increase in length and/or weight of the developing baby during pregnancy.
4. If a child is born to a surrogate mother, will that child show any resemblance to the surrogate mother? Give reasons for your answer.
5. New ethical and legal issues are arising with the more widespread use of reproductive technologies. In the United States, fertility clinics sell eggs and sperm from donors with specific attributes. They also advertise for donors with particular characteristics, such as 1.8 metres tall, athletic build, and no major family medical problems.

   Consider the ethical and legal problems that shopping for gametes might bring. For example, are gametes to be considered like any other commodity? And if a couple have paid for gametes to produce a bright and athletic child, what legal recourse should they have if the child does not meet their expectations?

   List as many ethical and legal issues that the advertising of, or for, gametes will create. Once you have finished your list, compare it with other members of your class. You may wish to debate the issues involved.
6. Embryos resulting from IVF are tested genetically before they are implanted into the mother's uterus. If an embryo was found to have a genetic disorder it would probably not be used for implantation. What are some of the moral and ethical issues associated with disposing of unwanted embryos?
7. Explain why menstruation does not take place during pregnancy.