

SUBJECT: LIFE SCIENCE

GRADE: 12

MODULE: 2 - Structure, control and processes in basic life systems of plants and humans

UNIT : 2 - The Human Reproductive System – Fertilization, implantation, pregnancy, birth and anti-natal care

By the end of this unit you should be able to:

- Describe the process of sexual intercourse
- Discuss the process of fertilization
- Identify the various stages of pregnancy
- Explain the development of the placenta
- Discuss the importance of parental care
- Describe the birth process
- Explain post natal care

LESSON OVERVIEW: (Knowledge areas)

1. Introduction
2. Sexual intercourse
3. Fertilization process
4. Implantation
5. Pregnancy/Gestation
6. Development of the placenta and amnion

(END OF LESSON – FERTILIZATION, IMPLANTATION AND GESTATION)

7. Parental care/Anti-natal care
8. Birth process
9. Postnatal care and multiple births
10. Review questions
11. Exercise

LESSON:

1. Introduction

You have learned that meiosis takes place in the ovary and testes to produce **haploid gametes**. The sperm cell must enter the female body and make its way to the egg cell, so that **fertilization** can take place to form a **diploid zygote**. Remember that humans require **internal fertilization** for the reproductive process to take place. The zygote will be a combination of the **hereditary characteristics** of both the male and the female. The zygote will develop into an embryo and then a foetus. The foetus will grow inside the female's body, in the uterus, where it can be protected. At full term, the female will give birth to **ensure survival and continuation** of the species.

2. Sexual intercourse

Humans reproduce by internal fertilization, which means that the sperm cells are inserted into the vagina of the female. This process is called **copulation**.

In order for copulation to occur, the male must first receive stimulation of the parasympathetic nervous system to cause **vasodilation** of the arterioles in the penis. This increases blood volume, resulting in the penis becoming erect. The erect penial issue causes the valve of the urethra to close to prevent the possibility of urination during ejaculation of the sperm cells. The rhythmic movement of copulation causes the smooth muscles of the epididymis, vas deferens, seminal vesicles, Cowper's gland and prostate to respond by contracting, resulting in wave-like contractions, associated with the ejaculation of the semen into the vagina. The semen has an **alkaline pH** to increase the normally vaginal acidity to a pH of 6 – slightly acidic.

Sperm cells are deposited up the vagina, close to the cervix. Sperm cells swim up through the cervix, the uterus and into the fallopian tubes where they can survive up to 3 days. Male sperm cells are **smaller** than the female sperm cells and swim faster. They survive for about 1 to 1,5 days. The female sperm cells are **larger**, swim slower and survive for up to 3 days because they have a greater energy reserve. Male

offspring will mean that the egg cell was ready for fertilization during the first 24 hours following copulation. Female offspring will mean that the egg cell was fertilized after the male sperm had died, so more than 1,5 days after copulation.

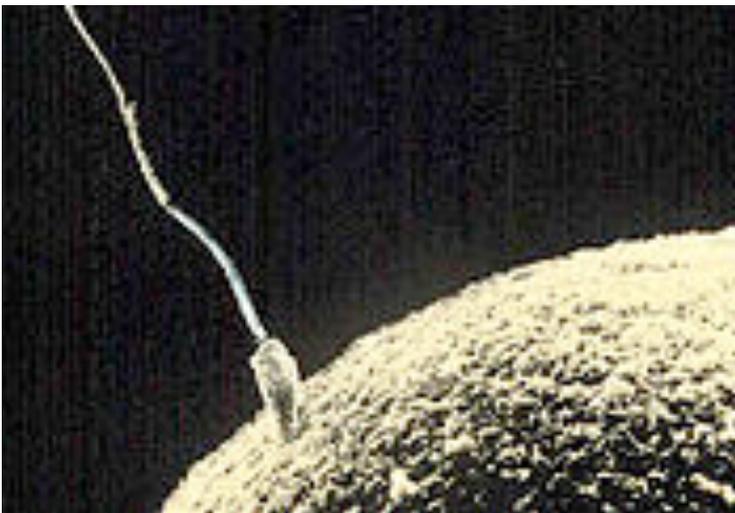
3. The Fertilization process

Definition of fertilization: it is the fusion of the sperm cell nucleus with the egg cell nucleus to form a diploid zygote. The diploid zygote contains **46 chromosomes** in the nucleus (23 from the sperm cell and 23 from the egg cell).

First, **capacitation** must take place. This is the process whereby the sperm cell first matures or activates before it can fertilize an egg cell. This takes place while the sperm cell is in the female genital tract.

Enzymes are released when the sperm head comes into contact with the jelly coat around the egg cell. The enzyme softens the **glycoproteins** around the egg cell to allow the head and the middle portion of one sperm cell to enter the egg. The tail is discarded. Once the egg cell has accepted **one sperm cell**, it immediately develops a membrane around itself, to prevent other sperm cells from entering it.

Once fertilization has taken place (joining of the male and female gametes), a diploid zygote is formed. This is called **conception**.

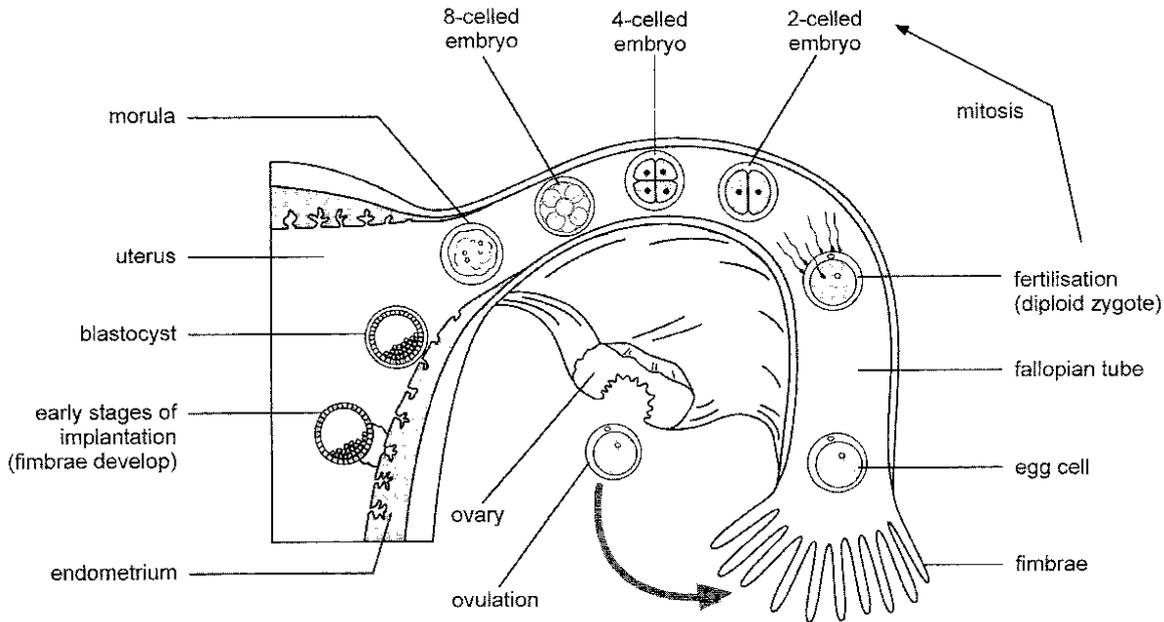


Sperm cell trying to enter an egg cell – with acknowledgement and thanks – www.wikipedia.org

4. Implantation

After fertilization takes place inside the fallopian tube, the zygote is moved by muscle contractions and pushed towards the **uterus**. The process takes about three days. During this time, the zygote undergoes mitosis and divides to form a solid ball called the **morula**. The morula develops into a **blastula** and attaches to the inner lining of the uterus (endometrium) after about six days. This attachment is called **implantation** and the female is considered to be pregnant.

The outer layer of the blastula is called the **trophoblast**, which develops into the **chorion**. The chorion has finger-like outgrowths that extend into the **endometrium** to anchor the developing embryo and increase the surface area for the absorption of nutrients.

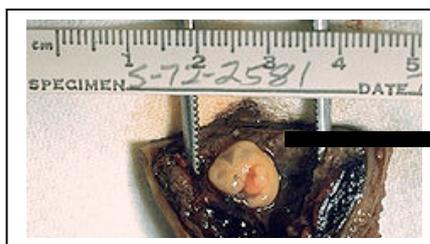


Diagrammatic representation of ovulation to implantation

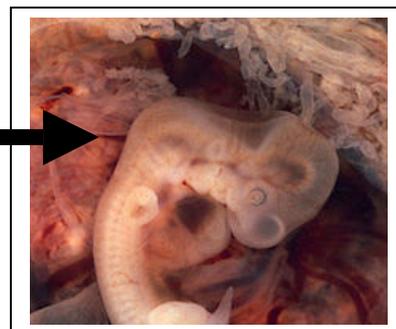
5. Pregnancy / Gestation

Pregnancy refers to the development of the embryo inside the uterus. It can also be called gestation. The embryo develops as follows:

- **Week 1:** Fertilization and implantation.
- **Week 2:** The three basic layers develop, namely the ectoderm, mesoderm and endoderm.
- **Week 3:** Embryo is about 2 mm long with the backbone, basic brain and spinal cord developing.
- **Week 4:** Embryo is about 5 mm long now. Umbilical cord, heart, blood vessels and gut develop.
- **Week 5:** Embryo is about 10 mm long with arms and legs developing. Heart begins to beat.
- **Week 6:** Embryo is about 12 mm long. Blood is pumping well now. Eyes and ears form.
- **Week 7:** Embryo is about 18 mm long. Internal organs, hands, feet and face have developed.
- **Week 12 to 16:** Embryo is now termed a foetus and is about 50 mm long. Organs, muscles, bones and sex organs are completely developed and foetus begins to move around in the uterus.
- **Week 17 to 20:** Foetus is about 160 mm long now. Hair starts to grow and fingerprints have developed.
- **Week 21 to 24:** Foetus moves around in the uterus. Eyelids open. Amniocentesis occurs at this point if required. This is the legal limit to abortions.
- **Week 25 to 28:** Foetus is swallowing amniotic fluid and urinating. It moves around a great deal in the uterus and responds to loud noises and music.
- **Week 30:** Foetus is about 240 mm long and engages into the pelvis with the head down. At this point the mother is uncomfortable and it will be difficult to control her bladder due to pressure from the growing baby.
- **Week 40:** Birth takes place.



5 week foetus





10 week foetus



17 week foetus – sonar scan photo



20 week foetus



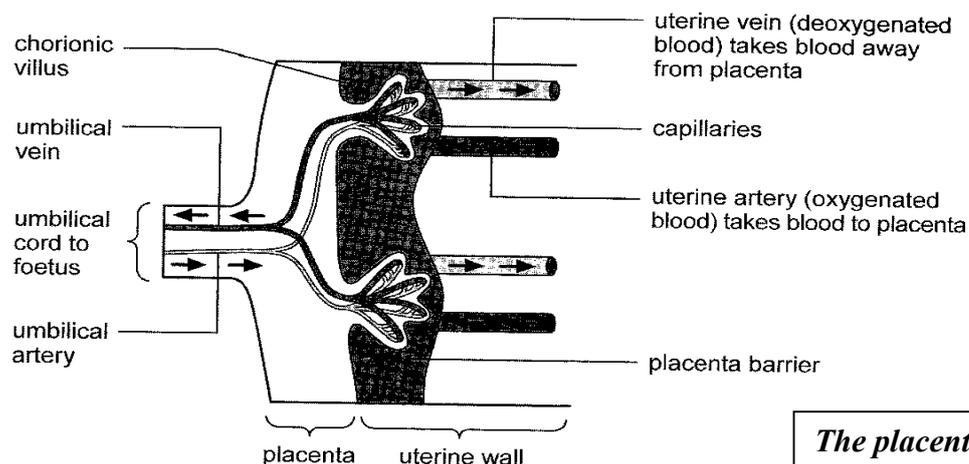
40 week foetus – ready for birth

Photos and diagrams with thanks and acknowledgement to www.wikipedia.org

6. Development of the placenta and amnion

The **placenta** is a structure that **forms a link** between the mother and the developing foetus, to ensure that there is **no direct transfer** of the mother's blood to the foetus. The placenta develops about 12 weeks after conception and allows for the safe exchange of a number of substances between the mother to the foetus:

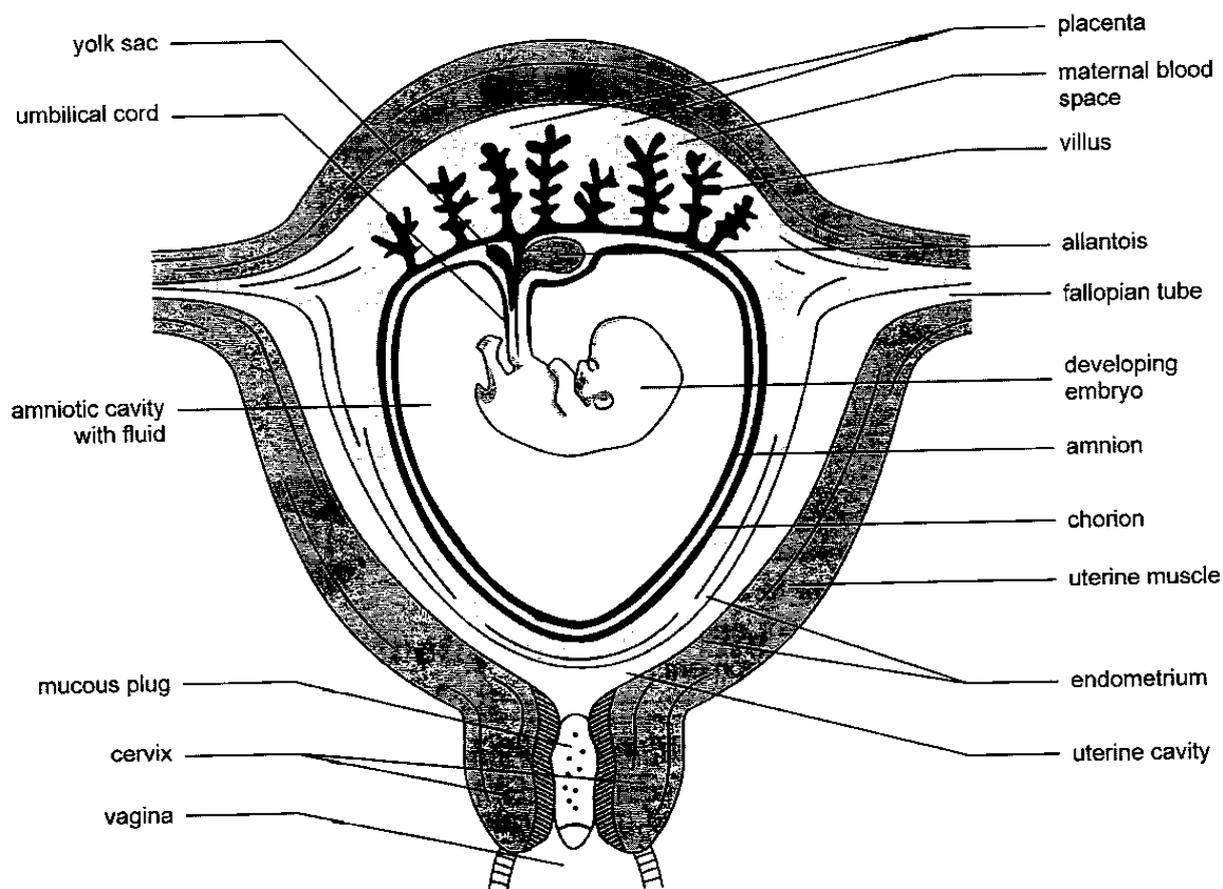
- **Nutrients, oxygen, hormones and antibodies** from mother to foetus
- **Carbon dioxide and wastes** from the foetus to the mother, for excretion by the mother
- **Harmful substances** like nicotine from cigarette smoking, alcohol, drugs and viruses like rubella (German measles), hepatitis B and HIV can also move through the placenta.



The placenta

The amnion is a membranous bag-like structure that develops around the embryo and is filled with **amniotic fluid**. It has the following functions:

- to **protect the embryo** by acting as a shock absorber and
- regulating the embryo's **body temperature**.



The embryo in the amnion

(END OF LESSON – FERTILIZATION, IMPLANTATION AND GESTATION / PREGNANCY)

7. Prenatal care / Anti-natal care

Pregnant women should visit their local clinic, doctor or gynaecologist on a monthly basis. Visits should increase during the last 8 weeks. The health and development of the foetus is checked and **ultrasound scans** are done to measure the growth of the foetus.

The mother is given vitamin and mineral supplements and encouraged to exercise regularly to ensure that the foetus receives the correct nutrients and oxygen required. Pregnant women are encouraged to attend **antenatal classes**. These classes assist women and make sure that first time mothers are prepared physically, mentally and emotionally for the birth. Fathers are encouraged to attend to provide support. In some cultures, the task of preparing the first-time mother is left to the **women in her family**, to ensure that the young mother is healthy and prepared for the birth process.

It is important to note that the pregnant mother's actions will directly effect her growing baby. **Smoking** causes babies to be up to 10% under-weight at birth. **Alcohol abuse** can cause mental retardation, poor growth rate, hyperactivity and miscarriage of the developing foetus. **Illegal drugs** cause miscarriage, crack addict babies, congenital abnormalities and damaged nervous systems.

Consider this:

Foetal alcohol syndrome (FAS) is caused by the **abuse of alcohol** by a pregnant mother. FAS causes mental retardation and many physical birth defects like abnormal facial features and heart and kidney problems. The baby's bones may also be deformed. In less severe cases, the child will have problems with memory and learning, attention span, communication, vision and/or hearing resulting in poor school results and antisocial behaviour. Children with FAS may develop psychiatric problems that could lead to incomplete education, criminal behaviour and unemployment.

The condition is **permanent**. It is up to the pregnant mother to ensure that she does not drink alcohol during pregnancy. It is her responsibility to ensure that she is healthy, eats properly and exercises frequently because all her actions directly affect her unborn child.

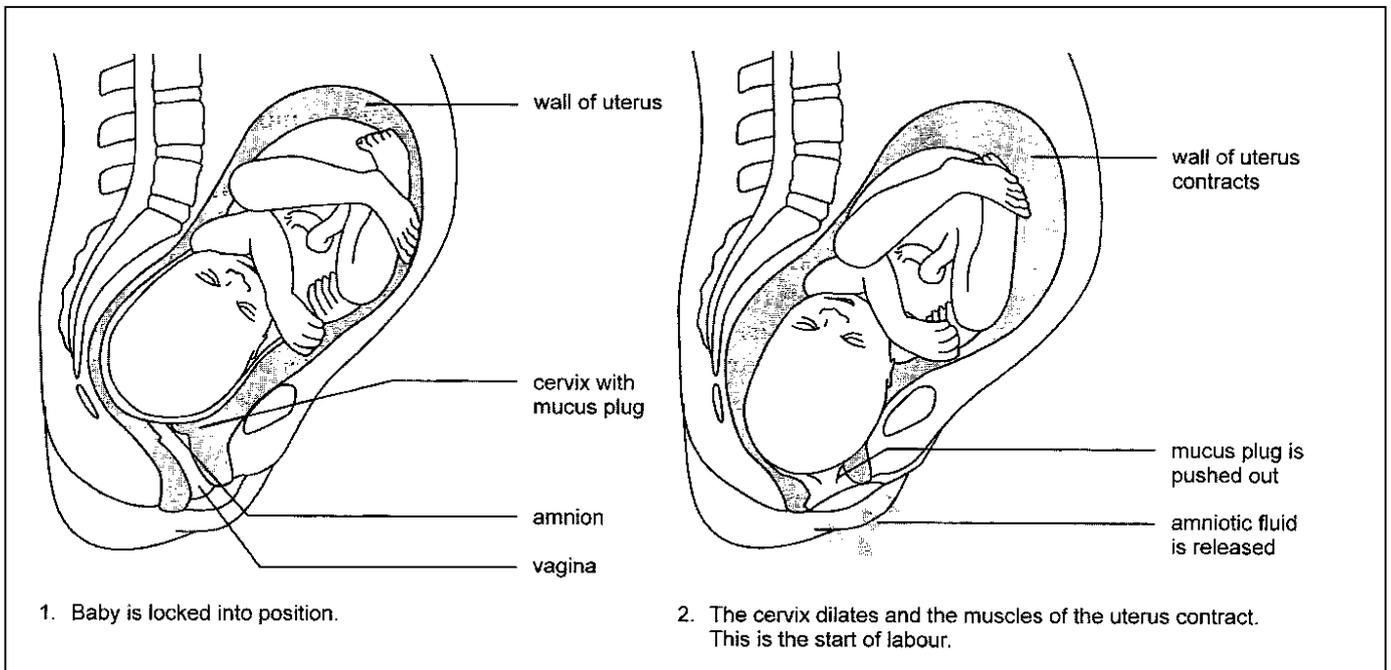
Mother to child transfer of HIV is an area of great concern. During 2004 approximately 700 000 babies worldwide were infected with HIV through the **birthing process or breastfeeding**.

AZT is a drug that is given to HIV positive mothers, during their first trimester. AZT prevents the HIV from being passed to the foetus through the finger-like outgrowths of the chorion and later, the placenta. AZT is given to the mother during **labour**. The drug is administered to both the mother and child for **one week** after the birth.

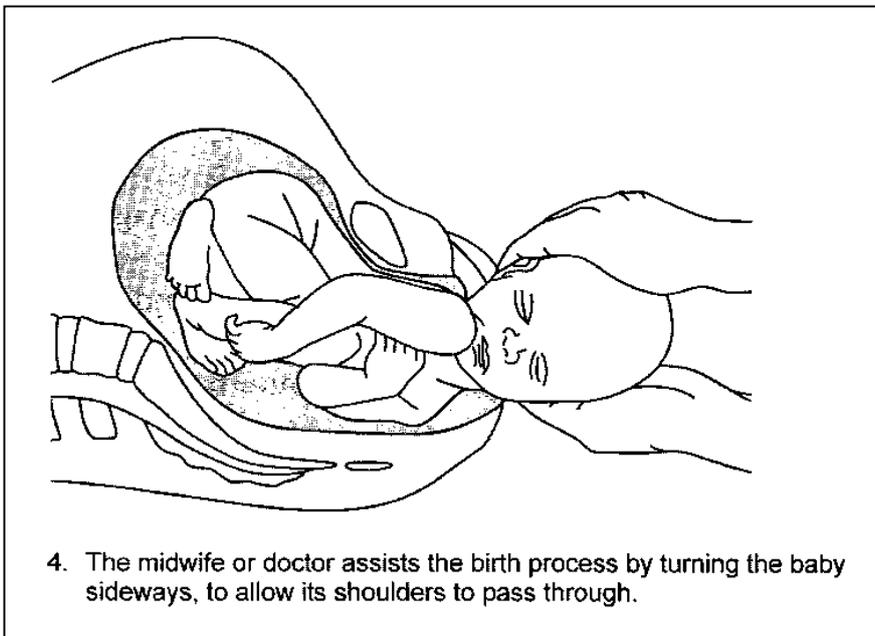
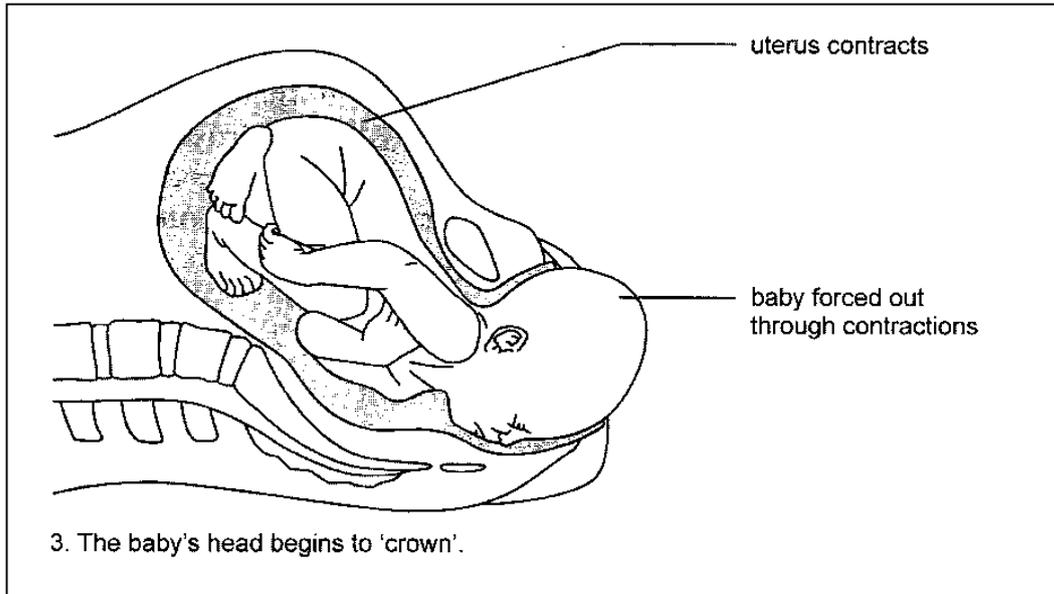
A **Caesarean section** (where the baby is surgically removed from the uterus by cutting through the abdomen) prevents the baby from coming into contact with the mother's blood and bodily fluids. This is the preferred method when the mother is HIV positive

8. The Birth process:

The birth process is called **parturition** because the baby 'parts' with the mother's body. Contractions indicate the onset of labour and are caused by the uterine wall. A hormone called **oxytocin** is secreted by the posterior lobe of the pituitary gland of the mother and causes the uterine contractions and the **dilation of the cervix**. When labour begins, the uterus contracts causing the **amnion to burst** – this is when people say that the 'water breaks' and the pregnant female is taken to hospital to deliver her baby.



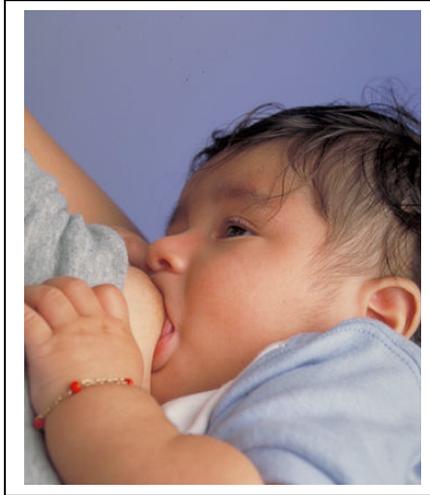
The uterine contractions force the baby down through the pelvic bones and the birth canal. When the head appears, it is called 'crowning'. The head comes out first then, the baby is turned sideways so that the shoulders can move through the canal. The umbilical cord is clamped off and cut (umbilical cord connects the baby to the placenta). The mother has more contractions to expel the placenta, which is commonly called the afterbirth.



A baby is born by Caesarean Section – photo with thanks and acknowledgement to www.wikipedia.org

9. Postnatal care (after the birth):

Parents are responsible for the protection, care, development and well-being of the new baby. Studies have shown that a baby can recognize the smell and voice of the mother at birth. Whether a mother breastfeeds or bottle-feeds her baby, it is important to hold the baby when doing so. The baby drinks better and this process creates a strong relationship between the baby and the mother.



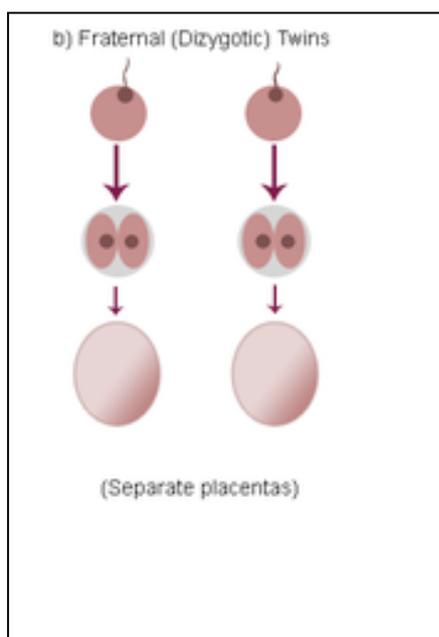
Young child breastfeeding from mother – with thanks and acknowledgement from www.wikipedia.org

9.1. Lactation:

After birth, the mother will produce a hormone called **prolactin** to stimulate milk production. The substance produced during the first few days is called **colostrums**, a fluid that contains antibodies, proteins and assists to clear out the digestive tract. When normal milk is produced by the mammary glands it is called **lactation**. Breast milk is white colour, contains antibodies and all the nutrients required by the developing baby. HIV positive mothers may not breastfeed their baby as the virus is present in the breast milk, so the baby is bottle-fed on powdered milk, available from clinics. This may pose problems in rural areas where clinics are very far away.

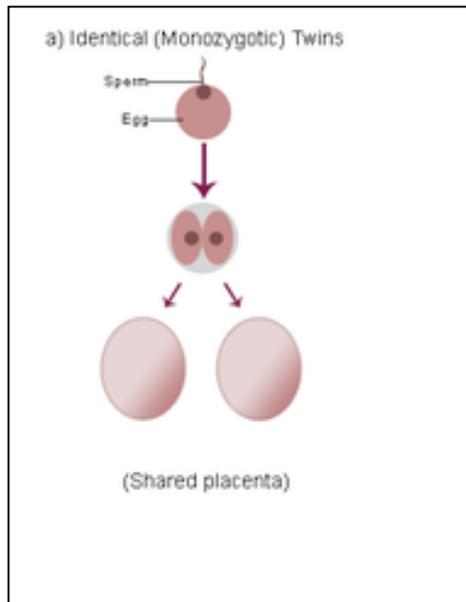
9.2. Multiple births: (Relate fraternal and maternal twins back to meiosis)

- When **more than one egg is released during ovulation**, fertilization is separate for each of the eggs. Each baby will look different and have the same or different sexes – depending on whether an X or Y sperm cell fertilizes the egg cells. The developing foetuses share the same uterus, but each foetus has a separate placenta and each has its own amnion. These babies are termed **dizygotic or fraternal twins**. (Di = two so two zygotes)



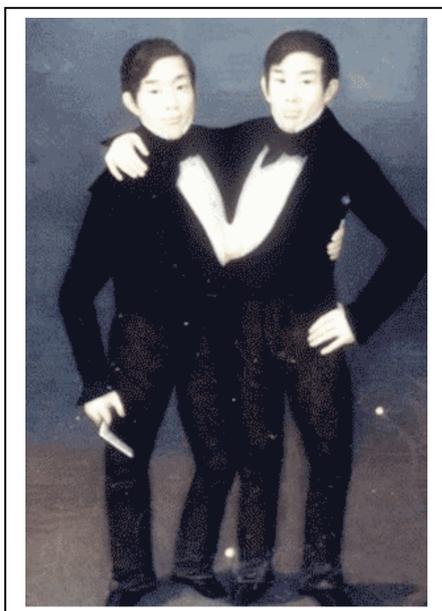
Dizygotic / Fraternal twins: photo and image with thanks and acknowledgement from www.wikipedia.org

- When **one egg is fertilized and the egg separates into two or more structures**, identical twins will result. The twins have the same sex and be identical in genetic inheritance and appearance. The placenta will be fused with a common embryonic membrane. These babies are termed **monozygotic or maternal twins**.



Monozygotic / Maternal twins: photo and image with thanks and acknowledgement from www.wikipedia.org

- Sometimes the **separation of the egg into two (monozygotic twins) is not complete**, resulting in the twins remaining **joined at areas** and they may even share internal organs. The **co-joined twins are called Siamese twins**.



Co-joined / Siamese twins: Chang and Eng Bunker - photo and image with thanks and acknowledgement from www.wikipedia.org

9.3. Premature babies:

The normal gestation period is **40 weeks**. In some cases, babies are born before their full term. We say the baby is premature meaning: before the baby is mature. These babies require specialized medical care because they may be weak, underweight and under-developed. The baby will be placed in an incubator, to regulate temperature and oxygen flow. They are also given steroids to assist with development. Generally hospitals will not provide medical assistance to a baby born at less than 700g. This will be less than 26 weeks of development.

REVIEW:

- In mammals, fertilization takes place in the
 - Fallopian tubes
 - vagina
 - uterus
 - ovary
- During the development of the embryo, the function of the amnion is to
 - give rise to the placenta
 - protect the embryo against harmful chemical substances
 - enclose the fluid which protects the embryo against injury
 - prevent the developing embryo from moving about
- The following is NOT a function of the placenta of mammals:
 - transports nutrients to the embryo
 - removes waste products from the embryo
 - protects the embryo against mechanical injury
 - protects the embryo against harmful chemical substances
- The fusion of an egg cell and a sperm cell is known as
 - copulation
 - cleavage
 - fertilization
 - ovulation
- Contraception pills work effectively because it
 - stops the development of the egg cell
 - prevents the thickening of the endometrium wall
 - impedes the movement of sperm in the fallopian tube
 - increases the movement of sperm in the fallopian tube
- The human embryo obtains:
 - nutrients and oxygen from the mother's blood
 - nutrients and CO₂ by diffusion across the placenta
 - yolk and albumen from the allantois
 - nutrients and oxygen by diffusion across the placenta
- The human foetus is immediately surrounded by the...
 - allantois
 - amnion
 - chorion
 - placenta
- The human foetus is surrounded by
 - amniotic fluid
 - air
 - wastes
 - mother's blood
- Foetal alcohol syndrome
 - is as a result of the pregnant female having a glass of wine now and again
 - causes mental retardation and physical birth defects in the baby
 - causes the baby to be lazy and to sleep badly
 - is a temporary condition
- Mother to child transfer of HIV is an area of great concern. Which of the following statements is true:
 - HIV is sometimes transferred through the birthing process or breastfeeding
 - AZT is a drug that prevents the HIV from being passed from the mother to the developing foetus
 - AZT is administered to the foetus during the first trimester of pregnancy
 - A Caesarean section is not the preferred method of birth for an HIV positive mother because there is too much blood

EXERCISE:

Pregnancies in schoolgirls are increasing with deep concern. The table below shows the number of pregnancies recorded in girls at one of the schools in the province over the past eight years. The annual enrolment of the number of girls, is also indicated. It is a mixed school and the numbers are arbitrary.

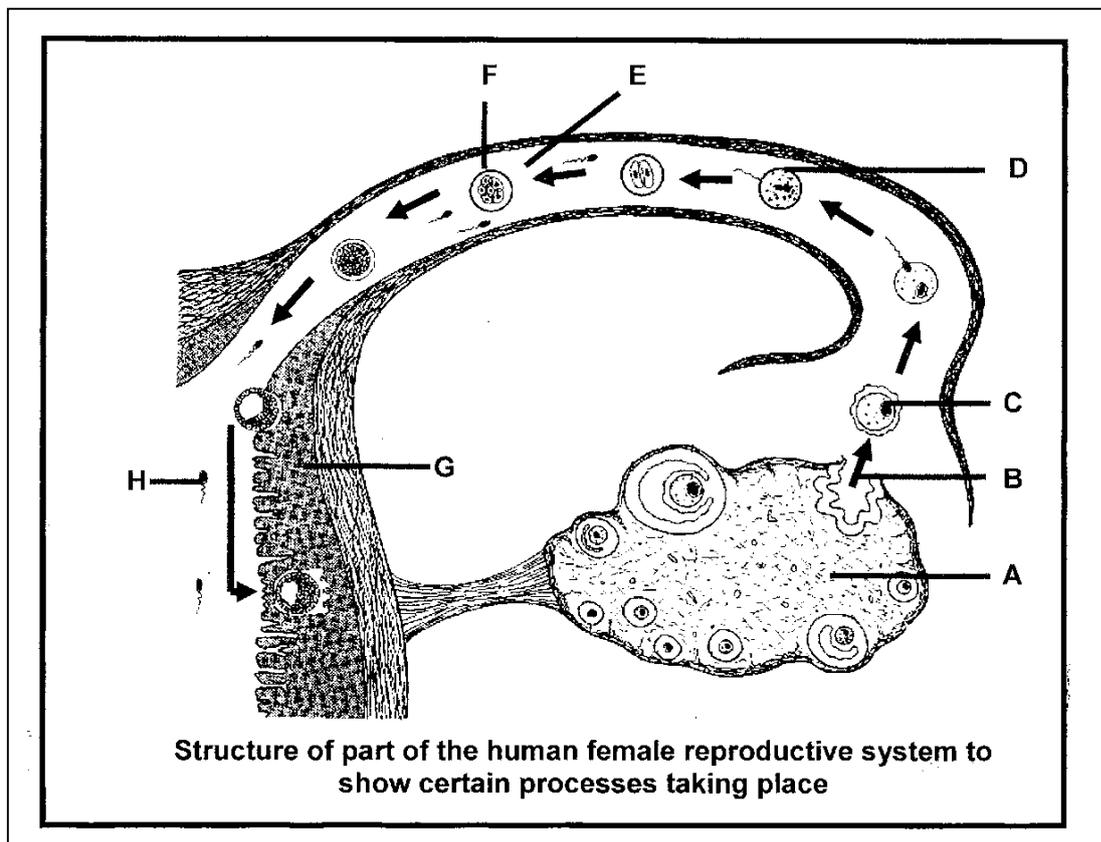
Study the table and answer the questions the follow.

Year	1989	1990	1991	1992	1993	1994	1995	1996
Number of pregnancies	3	4	2	4	10	11	9	12
Enrolment number of girls	406	383	411	397	400	383	398	416

- How many cases of pregnancies were recorded over the period of eight years?
 - What was the average annual number of pregnancies over this period. Show your calculation.
- In which **two** years was the enrolment number of girls in the school the same?
- In which **two** years was there a decrease in the number of pregnancies recorded?
- In which year was there the greatest increase of pregnancies?
 - What was the percentage increase? Show your calculations.
 - What percentage of girls were pregnant during that year? Show your calculations.
- State a possible reason for the
 - lower number of pregnancies during the **first** four years, and
 - increase in number of pregnancies over the **last** four years.
- What do you regard as the most detrimental effects of such a high level of pregnancies among teenagers?

HOME WORK

- The diagram below represents a part of the human female reproductive system after copulation. Study the diagram and answer the questions that follow.



- 1.1 Give labels for parts A, E and G respectively. (3)
 - 1.2 Name the process that takes place at B. (1)
 - 1.3 When, during the menstrual cycle, does the process mentioned in QUESTION 1.2 take place? (1).
 - 1.4 Describe the process represented by D. (3)
 - 1.5 Write down the number of chromosomes that would be present in the nucleus of the following:
 - a) Cell C (1)
 - b) One cell of F (1)
 - c) Cell H (1)
2. Read the passage below and answer the questions that follow.

Preformation and epigenesis theories

In the seventeenth century scientists believed in the preformation theory. One group of scientists believed that the egg cell contained a miniature human being that was completely formed. This group was called the ovists. Another group of scientists were called spermists because they believed that a miniature human being was found in a sperm cell. Many of the ovists and spermists reported seeing the completely formed miniature human being inside the sexual cells. The preformation theory was believed for almost 200 years. As equipment for microscopy improved the theory of epigenesis became widely accepted. In epigenesis it is believed that an embryo develops from a zygote. The theory of epigenesis is still accepted today.

- 2.1. What can we learn from this passage about the way in which scientific knowledge develops? (2)
 - 2.2. Why do you think scientists believed in the preformation theory in the seventeenth century? (2)
 - 2.3. What evidence from the passage rejects the preformation theory? (2)
 - 2.4. Keeping your current knowledge in mind, why would you reject the preformation theory? (2)
- (Both questions taken from the NSC Life Science Exemplar Examination 2008- Paper 1)**