Chapter 42 – Human Reproduction:

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<th>3.6 Reproduction and growth</th>
<th>Learning Objectives</th>
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| 3.6.2 Sexual Reproduction in the Human | 1. Give the general structure of the male reproductive system and the functions of the main parts.  
2. Outline the role of testosterone.  
3. Give the general structure of the female reproductive system and the functions of the main parts.  
4. Illustrate the role of meiosis in the production of sperm cells and egg (ova).  
5. Define “secondary sexual characteristics” and give the main male and female characteristics.  
6. Explain the menstrual cycle: the events and outline the role of oestrogen and progesterone.  
7. Explain copulation.  
8. Discuss birth control methods (natural, mechanical, chemical and surgical).  
9. Give the location of fertilisation.  
10. Discuss infertility: one cause of male infertility, one cause of female infertility and of corrective measures available.  
11. Explain Implantation, placenta formation and function.  
12. Discuss In-vitro fertilisation and implantation.  
13. Outline the process of birth.  
15. Outline the sequence of development from fertilised egg, to embryo, up to the 3rd month; include existence of amnion, placenta formation from embryonic and uterine tissue.  
16. Detailed study of the menstrual cycle and hormonal control.  
17. Give one example of a menstrual disorder and outline one possible cause, prevention and treatment. |

Reproduction is necessary for continuity of a species and of life.

- Sexual reproduction involves two parents.

In order to reproduce both males and females require:

1. A pair of structures to produce gametes.  
2. A series of tubes for transport.  
3. Hormone-producing glands to regulate reproduction.

Sexual reproduction cannot occur without Meiosis.

Both the Testes and Eggs contain diploid cells which must undergo Meiosis in order to produce haploid cells capable of fertilisation.
23 chromosomes (sperm) + 23 chromosomes (egg) come together to produce a single cell with 46 chromosomes which divides many times & develops into an individual.

**A GONAD** is an organ that produces sex cells in animals.

- In Males they are called Testes.
- In Females they are called Ovaries.

**THE MALE REPRODUCTIVE SYSTEM**

**Testes/Scrotum**

- Testes are stored outside the body in the **Scrotum**.
- This allows them to be slightly cooler than body temperature 35°C, to allow meiosis to occur.
- Each testis is made of ~50cm of tubules which are responsible for meiosis to produce haploid sperm.

**Epididymis**

- There is one Epididymis on the outside of each testis.
- They store the sperm for ~6 weeks to allow them to mature.
- If not released the sperm gets broken down and taken back to the bloodstream by resorption.

**Sperm Duct**

- The Sperm Duct carries sperm into the urethra.
- *A Vasectomy* is an operation involving cutting the sperm duct as a form of sterilisation.

**Urethra**

- The Urethra carries both Semen and Urine out of the body.

**Glands**

- The Seminal Vesicles, Prostate Gland and Cowper’s Glands are located along the sperm duct.
• They produce **seminal fluid** which nourishes the sperm and enables them to swim.

• **SEMEN** is the seminal fluid with the sperm.

**Penis**

• Ejaculates/releases sperm inside the female body. *(Ejaculation is the release of sperm from the penis).*

• A **foreskin** covers the tip and may be removed by **Circumcision** for health or religious reasons.

• The penis is generally **flaccid** but once aroused becomes **erect** due to increased blood flow.

**Male Hormones**

• An **Androgen** is a male Hormone.

• 3 Key Hormones
  
  – FSH, LH, Testosterone

• *(FSH) Follicle Stimulating Hormone*
  
  – Produced by pituitary gland.
  
  – Causes sperm producing cells in the testes to begin Meiosis and produce sperm.

• *(LH) Luteinising Hormone*
  
  – Produced by pituitary gland.
  
  – Stimulates the testes to produce Testosterone.

• **Testosterone**

• The main androgen, produced by Testes

• Causes primary male characteristics in developing babies & secondary male characteristics at puberty.

**SECONDARY SEXUAL CHARACTERISTICS** are those features that distinguish males from females, apart from the sex organs themselves.

• Growth of pubic, underarm and facial hair.

• Enlargement of larynx (voice break).

• Growth spurt & widening of shoulders.

• Muscle and bone development.

• Increased sebum on skin (spots).
Sperm

- Sperm-producing cells are diploid (46), they divide by MEIOSIS to produce haploid (23) sperm cells.
- First produced when men hit puberty and continue throughout life.
- Acrosome: contains enzymes that help it break into the egg.
- Nucleus: contains 23 chromosomes including X or Y.
- Flagellum: causes sperm to swim.

INFERTILITY is the inability to produce offspring.

- **Cause:**
  - Low sperm count as a result of:
    - Smoking, - Excessive drinking, -Drug use, -Use of steroids,
    -Mumps, -Hormonal Imbalance

- **Corrective Measures:**
  - Change in diet/lifestyle
  - Administration of hormones

FEMALE REPRODUCTIVE SYSTEM

Ovaries

- The Female Gonads. They produce eggs and hormones.
- The ovaries contain 1 million potential eggs at birth and this decreases with age.
• At puberty ~20 eggs are made by meiosis each month, usually only one survives.
• This egg then gets surrounded by a **Graafian follicle** which produces oestrogen.
• As the Graafian follicle matures it swells and eventually bursts releasing the egg.

**OVULATION** is the release of an egg from the ovary.

- After ovulation the Graafian follicle fills with a yellow liquid and turns into the **Corpus Luteum**.
- This releases the hormone **progesterone**.

**Fallopian Tubes**

- The Fallopian Tubes with the Uterus are called the **Oviduct**.
- They are muscular tubes that carry the egg to the uterus.
- **Fertilisation** is the fusion of a sperm and an egg to form a zygote.
  - **It occurs in the Fallopian Tubes**.

**Uterus (Womb)**

- The Uterus is a muscular structure the size of your fist.
- It develops a lining (**Endometrium**) to nourish a developing embryo in the event of pregnancy.

**Vagina**

- The Vagina is a muscular tube.
- It allows entry of sperm and exit of the baby.
- The **Hymen** is a ring of skin the covers the vagina and is easily broken.

**The Menstrual Cycle**

- **The Menstrual Cycle** is a series of events that occurs in females, every 28 days on average, if fertilisation has not taken place.
• It begins at puberty and continues until the Menopause (45-55).

**DAY 1-5**
• The endometrium breaks down and is released through the vagina. This is called *Menstruation*.
• A new egg is produced in the ovary by *Meiosis*, the *Graafian follicle* develops, maturing the egg.

**DAY 6-14**
• The Graafian Follicle produces *Oestrogen*.
• Oestrogen causes the *endometrium to thicken* again and prevents further eggs from being produced.

**DAY 14**
• *Ovulation* (the release of an egg from the ovary) occurs when the Graafian Follicle bursts.
• The egg passes along the fallopian tube where it survives for ~48 hours.

**DAY 14-28**
• The Graafian Follicle becomes the *Corpus Luteum*.
• This produces *progesterone* causing the endometrium to thicken further and preventing further egg release.
• If fertilisation does not occur, the *Corpus Luteum breaks down*, levels of progesterone drop and the lining will begin to breakdown by day 28.

**Female Hormones**
• *Oestrogen*:
• Causes the Endometrium to thicken for first 14 days of the cycle.
• **Progesterone:**
  - Causes the Endometrium to thicken for second 14 days of cycle.
  - Both prevent production of eggs from the ovary. They are used together in the combined pill as a contraceptive.

**Secondary Female Sexual Characteristics**

- Growth of pubic & underarm hair.
- Enlargement of breasts.
- Widening of Pelvis (hips).
- Growth spurt due to testosterone.
- Increase in body fat.
- **Infertility** is the inability to produce offspring.

- **Cause:**
  - Failure to ovulate, - Hormone imbalance, -Endocrine gland failure,
  - Polycystic ovaries, - Tumour on ovaries, -Stress

- **Corrective Measures:**
  - Change in diet/lifestyle
  - Administration of hormones
  - Surgery to remove obstruction

**Hormonal Control of Menstrual Cycle (H.L.)**

**FSH (Follicle Stimulating Hormone)**

- **Site of Production:** Pituitary Gland
- **Time of Production:** Day 1-5
- **Function(s):** Stimulates egg production. Frequently used in fertility treatments (can result in multiple eggs and thus multiple births).

**Oestrogen**

- **Site of Production:** Graafian Follicle (Ovary)
- **Time of Production:** Day 5-14
- **Function(s):** Inhibits FSH (and thus egg production) by negative feedback,
  - Causes Endometrium to thicken, - Stimulates LH production.
LH (Luteinising Hormone)

- **Site of Production**: Pituitary Gland
- **Time of Production**: Day 14
- **Function(s)**: Causes Ovulation, development of Corpus Luteum and thus stimulates progesterone production

Progesterone

- **Site of Production**: Corpus Luteum (Ovary)
- **Time of Production**: Day 14 - 28
- **Function(s)**: Inhibits FSH and LH preventing egg production and ovulation
- Prevents uterus contractions
- By day 28 if no fertilisation the uterus contracts and menstruation occurs due to low levels of progesterone and oestrogen.

![Graph showing hormone levels during the menstrual cycle.]

Menstrual Disorder

**Fibroids**

- Slow growing **Benign Tumours** on the uterus
- Result from overproduction of cells but do not spread
- Small ones cause no symptoms
- Larger ones can cause *pain, heavy menstrual bleeding, miscarriage, infertility*

**Treatment**

- Removal by surgery
- Hysterectomy if severe
Stages of Copulation

- **Sexual Arousal**
  - In the male involves the penis filling with blood and becoming erect.
  - In the female involves the vagina becoming lubricated.

- **Sexual Intercourse, Coitus or Copulation**
  - Involves the penis being placed inside the vagina.

- **Orgasm**
  - The physical and emotional sensations experienced at the climax of sexual excitement.
  - During Orgasm heart and breathing rates increase, blood pressure increases.
  - In the female the uterus and vagina contract.
  - In the male ejaculation occurs. **Ejaculation** is the release of semen from the penis.

- **Insemination** is the release of semen into the vagina, just outside the cervix.

- **Chemotaxis** is the way in which sperm are attracted to the egg due to a chemical released by the egg. Sperm compete for the egg, some will lose direction, some will be killed by white blood cells or acid.

  **FERTILISATION** occurs when the nucleus of the sperm fuses with the nucleus of the egg, forming a diploid zygote.

- It occurs in the **fallopian tube**.
  - Sperm survive for up to 7 days inside the female, the egg for 2 days. Fertilisation is most likely to occur between day 9 and 18 (the fertile period) of the cycle.

- The **acrosomes** on the front of the sperm release digestive enzymes to break the membrane of the egg.

- One sperm head successfully enters and in the process loses its tail.

- The egg then forms a **fertilisation membrane** to prevent further sperm entering.
In Vitro Fertilisation

- **IVF** involves removing eggs from an ovary and fertilising them **outside** the body.

- It is used in cases where:
  - Females fail to produce eggs naturally
  - Females fallopian tubes are blocked
  - Males have low sperm counts

- Females are given fertility drugs for 2 weeks.
- The eggs are then surgically removed.
- They are mixed with sperm in a petri dish.
- If after 2 days an embryo has formed a number are placed into the uterus in the hope they will **implant** naturally.

Implantation

- **Implantation** is the embedding of the fertilised egg (embryo) into the lining of the uterus.

- It occurs 6-9 days after fertilisation.

- A membrane called the **Amnion** develops around the embryo. The amnion produces amniotic fluid which **protects** the embryo.

The Placenta

- **Development**

- After implantation an outer membrane called the **chorion** develops around the embryo.

- The chorion develops projections called villi which interact with the blood vessels in the endometrium to form the placenta.
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  • After implantation an outer membrane called the **chorion** develops around the embryo.

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  • It is the only animal organ formed from the tissues of two individuals, the **embryonic tissue** of the embryo and the **uterine tissue** of the mother.

• **Functions**

• **Exchange**
  
  • It allows gases, nutrients, wastes, antibodies, drugs and hormones to pass between mother and embryo

• **Blood**
  
  • It prevents the mothers blood mixing with the embryos, preventing damage due to different blood types and blood pressure

• **Hormones**
  
  • Produces Progesterone for growth.
Zygote Development

- **Day 1:** Fertilisation Occurs
- **Day 3:** Zygote undergoes Mitosis forming the **Morula**, (Morula is a solid ball of cells formed from a zygote by mitosis)
- **Day 5:** The Morula develops into a hollow ball of cells called a **Blastocyst** and then moves to the uterus, (Blastocyst is a hollow ball of cells formed from a morula)

Embryonic Development

- **Day 10:** Inner cells in the blastocyst form the embryonic disc. **Germ Layers develop.** Germ Layers are basic layers of cells in the blastocyst from which all adult tissues and organs will form.
  - Each germ layer gives rise to specific structures in the developing embryo,

<table>
<thead>
<tr>
<th>Germ layer</th>
<th>Organ or system produced</th>
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<tbody>
<tr>
<td>Ectoderm</td>
<td>Skin, nails, hair, nervous system</td>
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<tr>
<td>Mesoderm</td>
<td>Muscles, skeleton, excretory system, respiratory system, circulatory system, reproductive system</td>
</tr>
<tr>
<td>Endoderm</td>
<td>Inner lining of digestive, respiratory and excretory systems; liver and pancreas</td>
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- **Week 4:** Heart, brain and spinal cord form.
- **Week 5:** Internal organs and Limbs begin to form.
- **Week 6:** Eyes, Mouth, Nose, Ears become visible.

   **Week 6 Embryo**
Week 8: Major body organs are formed, cartilage begins to be replaced by bone. Now called a Foetus.

Week 12 (3 months): Bones, organs and limbs become more apparent.

• Nerves and muscles become co-ordinated.
• Foetus sucks thumb, kicks and teeth begin to form in gums.
• Placenta becomes fully functional.

Gestation is the length of time spent in the uterus, from fertilisation to birth.

• It lasts 266 days (38 weeks, 9 months) in humans.

Birth

• Throughout pregnancy Progesterone and Oestrogen production levels increase.
• For the first 10-12 weeks progesterone is produced by the corpus luteum in the ovary.
• After 12 weeks the placenta acts like an endocrine gland and produces it and others.
• The placenta stops producing progesterone immediately before birth.
• Low levels of progesterone cause the uterus walls to contract.
• At the same time the mother’s pituitary gland produces Oxytocin which causes the onset of contractions and labour. It is also seen as the ‘love’ or bonding hormone.
• Stage 1 (~12 Hours)
  
  Uterus contractions push the foetus down toward the cervix.
  
  The waters break when the mucous plug is expelled from the cervix and the amniotic sac breaks.
  
• Stage 2 (20 mins - 1 Hour)
  
  The cervix dilates, the foetus is pushed down through the vagina.
  
  Once the baby is out the umbilical cord is clamped and cut.
  
• Stage 3 (5 - 30 mins)
  
  The afterbirth (placenta and umbilical membranes) are expelled.

Breastfeeding

• Lactation is the secretion of milk by the mammary glands (breasts) of a female.
• Colostrum is ‘first milk’. It is a thick yellow liquid produced for a few days after birth. It is very high in minerals, proteins and antibodies.
• Prolactin is produced by the pituitary gland after birth and is the hormone that stimulates milk production. This continues until breast feeding is stopped.

Benefits

• It contains the ideal combination of nutrients required by a baby
• It contains antibodies from the mother helping the babies immune system
• Safer as it is sterile and has no risk of contamination from bottles, water, etc.
• Helps the mother to recover more quickly and lose body fat
• May help reduce the risk of breast cancer

Birth Control

• Birth Control refers to methods taken to limit the number of children that are born.
• **Abortion** is the termination of a pregnancy.

• **Contraception** is the deliberate prevention of fertilisation or pregnancy.
  
  – There are 4 types:
  
  – Natural
  
  – Mechanical
  
  – Chemical
  
  – Surgical

• **Natural Contraception**

• Involves not having intercourse during the fertile period. This can be detected by monitoring body temperature and mucous production.

• Not very reliable.

• **Mechanical Contraception**

• Involves using a physical barrier to prevent sperm from reaching the egg.

• They include: Condoms (male or female), Diaphragms & Caps.

• **Chemical Contraception**

• Involves using spermicides or hormones.

• **Spermicides** are substances that kill sperm (usually used with mechanical methods)

• **Hormones** involve use of progesterone and oestrogen to prevent ovulation and include use of:
  
  – The Pill, Injections & The Bar.

• **Surgical Contraception**

• Involves sterilisation of females or males.

• Female sterilisation involves tying or cutting the fallopian tubes to prevent sperm reaching the egg.

• Male sterilisation or vasectomy involves tying or cutting the sperm duct to prevent the release of sperm.