CHAPTER 4: REPRODUCTION

SEXUAL AND ASEXUAL REPRODUCTION

1. Reproduction.
   a. Reproduction is a process of generating offspring.
   b. Reproduction is a biological process that occurs in all living organisms.

2. Importance of reproduction
   a. Reproduction is important for the survival of all living organisms.
   b. Reproduction is also important in maintaining continuity of organisms.
      Without a mechanism for reproduction, life would come to an end.

3. There are two types of reproduction, sexual and asexual reproduction.

Sexual reproduction

1. Sexual reproduction involves the joining of a male and a female sex cell.
2. Fertilisation:
   i. Fertilisation happens when male and female sex cells are physically joined together.
   ii. Fertilisation that happens inside a female’s body is called the internal fertilisation.
   iii. Fertilisation that happens outside a female’s body is called the external fertilisation.
3. Organisms that reproduce sexually are human beings, mammals, reptiles, fish, birds, insects and some flowering plants.

Asexual reproduction

1. Asexual reproduction does not involve the fusion of male female sex cells.
2. In asexual reproduction, a simple cell is divided by itself to produce an exact duplicate of an organisms.
3. There are five types of asexual reproduction: PMR 03
   i. binary fission - amoeba, paramecium
   ii. budding - hydra
   iii. spore formation - fern
   iv. vegetative - grass
   v. rejuvenation - starfish, flatworm, lizard
4. Organisms that reproduce asexually are:
   i. paramecium
   ii. hydra
iii. planarian
iv. amoeba
v. starfish
vi. some flowering and non-flowering plants

5. Binary fission:
i. Mature organisms that have reached maximum size perform cell division to produce two daughter cells.
ii. The daughter cells produced will develop and have the same characteristics as their parent organism.
iii. The process of binary fission begins with the division of the nucleus, followed by the division of the cytoplasm.

iv. Examples of organisms that perform binary fission are amoeba, paramecium and euglena (algae).

6. Rejuvenation (regeneration):
a. Rejuvenation is the replacement or regrowth of missing or injured body part.
b. For example, if a planarian is cut horizontally, the head will grow a new tail and the tail section will grow a new head.
c. This way, a planarian that is damaged or cut into several pieces may grow into many new organisms.
d. Examples of organisms that reproduce via rejuvenation are planarian, dugesia (flatworm), starfish, lizard tail.

7. Budding:
a. Involves protoplasmic outgrowth containing a nucleus projecting from the side of the parent cell.
b. The outgrowth will develop and grow to form a new bud.
c. Examples of organisms that undergo budding are hydra, tapeworm and yeast.

8. Spore formation (sporation):
a. Mature spore are black in colour and produced and stored in the sporangium.
b. Spores will released when the sporangium bursts. The tiny and lightweight spores are blown by wind to other places.
c. When a spore is transported to a place with favourable growing conditions, it will germinate to form new growths.

d. Examples of organisms that perform spore formation are Rhizopus (bread mould), mosses, mushrooms and ferns.

9. Vegetative reproduction:
   a. New plants are produced from existing plant organs or parts of organisms.
   b. The new plants have the same genetic makeup as the original plant.
   c. Flowering plants can carry out vegetative reproduction.
   d. There are several types of vegetative reproduction:
      i. Rhizomes (ginger, lalang, asparagus)
      ii. Tubers (potatoes)
      iii. Bulbs (onion)
      iv. Corms (yam, gladiokus)
      v. Runners (strawberries)
      vi. Suckers (banana)
   e. Examples of plants that carry out vegetative reproduction are:
      i. galangal
      ii. sweet potatoes
      iii. strawberries
      iv. ginger
      v. potatoes
      vi. shallots

THE MALE REPRODUCTIVE SYSTEM PMR 05
http://www.kumc.edu/instruction/medicine/anatomy/histoweb/male/male.htm
http://kidshealth.org/parent/general/body_basic/male_reproductive.html

1. The testes are each hung outside the body in a sac called the scrotum.
2. The function of the testes is to produce the male gametes or sperms.
3. The testes are located outside the body in the scrotum because sperms cannot form at human body temperature.
4. The sperms move out from the testes in the sperm ducts.
5. The prostate gland produces a milky fluid that protects the sperms.
6. The mixture of sperms and the secretion of the prostate gland is called semen.

7. The urethra is a tube that allows sperm to move from the sperm duct to the penis. The urethra is also the tube that allows urine stored in the urinary bladder to flow out of the body.

8. The function of the penis is to transfer sperms into the female reproductive organ.

### Organs of the male reproductive system - the structures and functions

<table>
<thead>
<tr>
<th>organ</th>
<th>Structure</th>
<th>Functions</th>
</tr>
</thead>
</table>
| testis (plural: Testes) | An oval-shaped organ located the scrotum.                                  | 1. produces sperms.  
                          |                                                                          | 2. Produces male sex hormones, such as androgen and testosterone.          |
| Epididymis             | A coiled tube within the scrotum.                                          | 1. stores sperms (until they are natured) before they enter the sperm duct.|
| sperm duct             | Connects and directs sperm from testes to seminal vesicles.                | 1. transports sperm from the testes to the urethra.                        |
| seminal vesicle        | A pair of glands located at the urinary bladder.                           | 1. secretes a mucous-like liquid into the sperm duct.                      |
|                        |                                                                          | 2. this liquid is rich in sugar, which provides energy for the sperm cells.|
|                        |                                                                          | 3. the mixture of semi liquid and sperm is called semen.                  |
| urethra                | A fine tube that connects the urinary bladder to the penis.                | 1. acts as excretory tube to discharge urine and sperm out of the male's body. |
|                        |                                                                          | 2. ejaculates semen through the penis.                                    |
| penis                  | Cylindrical-shape organ which has erectile tissue.                        | 1. sends semen directly from the male body to the female reproductive system during sexual intercourse. |
| scrotum                | Sac which protects and supports the testes.                               | 1. locates the testes outside the body.                                   |
|                        |                                                                          | 2. maintains the temperature of the testis at 34°C which is lower than normal human body temperature of 37°C. |
| prostate gland         | Muscular gland and located below the urinary bladder and surrounds the top portion of the urethra. | 1. secretes thinner alkaline liquid and vitamin E derivative into the semen. |
|                        |                                                                          | 2. this helps sperm move and survive.                                     |

### The role of sperm in reproduction

http://hes.ucf.k12.pa.us/gclaypo/repro/malerepr2.html

1. A sperm is a male sex cell.
2. A sperm measures about 0.06 mm which makes it's the smallest cell in a man's body.
3. It cannot be seen by naked eye. Under a microscope, sperm look like tadpoles.
4. A sperm cell is need to fertilise a woman's egg (called the ova) to produce an offspring.
5. A sperm is made up of three parts:
   i. the head - contains genetic material (nucleus)
   ii. midpiece - is the motor of the sperm (middle region)
   iii. tail - enables the sperm to move.

**THE FEMALE REPRODUCTIVE SYSTEM**

1. The sexual organs of the human female reproductive system are the ovaries, the fallopian tubes, the uterus and the vagina.
2. The function of the ovaries is to produce egg cells or ova.
3. An ovum is released by either of the ovaries about every 28 days.
4. The ovum moves out from the ovary into the fallopian tube or oviduct.
5. The fallopian tubes connect the ovaries to the uterus. The uterus is also known as the womb.
6. The uterus is the place where the foetus develops during pregnancy. It has a thick wall which is supplied with many blood vessels.
7. The wall of the uterus is the place where an embryo is implanted. The development of embryo is completed in the uterus.
8. The cervix is the neck of the uterus. The wall of the cervix secretes cervical mucus to protect the reproductive parts against bacteria infection. The cervix opens into the vagina.
9. The function of the vagina is to receive sperms. It also serves as birth canal during childbirth through which the baby comes out of the mother's body.
The role of an ovum in reproduction

1. A normal woman has a pair of ovaries in her abdominal region.
2. The ovaries are able to produce female gametes called the ova.
3. An ovum is a spherical structure surrounded by a layer of jelly coating. It consists of a nucleus filled with chromosomes and cytoplasm containing stored food.
4. An ovum is larger than a sperm, with a diameter of about 0.1 mm. Unlike the sperm, it cannot move by itself.
5. Only one ovum is released from the ovary during a particular period of time.
6. Ovum will be released from the ovary of a woman who has reached puberty at about 12 years old. The ovaries will stop producing ova when a woman is about 55 years old or when she reaches menopause.
7. The ovum is the largest cell in the female body because it contains dense cytoplasm to provide food to the embryo at the early stage of its development.
8. An ovum that is not fertilised by a sperm can only survive for 36 hours in the human uterus. After this period, the ovum will die and is discharged from the human body.

Draw figure 4.14 page 56

Compare and contrast male and female gametes

<table>
<thead>
<tr>
<th>sperm</th>
<th>differences</th>
<th>ovum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 mm to 0.05 mm</td>
<td>size</td>
<td>0.1 mm - 0.12 mm (largest cell)</td>
</tr>
<tr>
<td>many</td>
<td>number</td>
<td>a few</td>
</tr>
<tr>
<td>can move on its own</td>
<td>mobility</td>
<td>does not move on its own</td>
</tr>
<tr>
<td>tadpole-shaped</td>
<td>shape</td>
<td>sphere and round</td>
</tr>
<tr>
<td>Testis</td>
<td>Place of production</td>
<td>Ovary</td>
</tr>
<tr>
<td>Million</td>
<td>Number produced</td>
<td>One at a time</td>
</tr>
<tr>
<td>Up to 72 hours</td>
<td>Life span</td>
<td>Up to 36 hours</td>
</tr>
</tbody>
</table>
THE MENSTRUAL CIRCLE

1. A woman’s ovary release ovum according to a particular period of time known as the menstrual cycle.
2. The menstrual cycle is the regular monthly cycle involving ovulation and menstruation. The duration of the menstrual cycle is about 28 days.
3. Ovulation is the release of a mature ovum from an ovary.
4. Menstruation is the discharge from the vagina when the ovum fails to be fertilised by a sperm.
5. Menstruation occurs when the uterus lining breaks down. Hence, the broken lining of uterus wall, dead ovum and blood will be discharged from the body.
6. The changes that take place throughout the menstrual cycle are controlled by two types of sex hormones, namely oestrogen and progesterone.
7. Some women will experience premenstrual syndrome (PMS) for a few days before the onset of the menstruation. The symptoms of this are anxiety, nervousness, headaches, mood swings and tiredness.

FERTILISATION AND PREGNANCY

A. Formation of zygote

1. During the sexual intercourse 300 to 500 millions of sperms are deposited by the penis into the vagina.
2. All of the sperms deposited in the vagina, only a few hundred arrived in the fallopian tube. Most sperms have been destroyed by the acidic fluids secreted by the vagina.
3. However some sperm survive because of the neutralising effect of the semen.
4. The surviving sperms swim up the vagina, through the cervix into the uterus and finally reach the fallopian tube.
5. In the fallopian tube, only sperm will succeed in fusing with an ovum.
6. Fertilisation is said to take place when the nucleus of the sperm combines with the nucleus of the ovum.
7. When the nucleus of the sperm penetrates the ovum, the tail of the sperm will drop off and is left outside the ovum.
8. As soon as a sperm penetrates an ovum, a fertilisation membrane is formed outside the ovum to prevent other sperms from entering the ovum.
9. The product of fertilisation of the nuclei of both gametes is a zygote. Zygote is the ovum which is fertilised. At this stage, a woman is said to be pregnant.

10. The period of development from fertilised egg to birth is known as pregnancy. (at least 38 - 39 weeks)

11. After fertilisation, the zygote divides itself numerous times to form 2 cells, 4 cells, 8 cells and so on.

12. Then, the zygote moves along the fallopian tube to the uterus. The movement of the zygote is caused by the push force of the cilia in the fallopian tube.

13. The zygote takes place about 7 days to reach the uterus.

**B. Implantation of zygote PMR 03, 04**

1. After about 7 days, the zygote attaches itself to the wall of the uterus, which has been thickening in preparation to receive a zygote.
2. Attachment of the zygote to the lining of the uterus is called implantation.
3. If the implantation is strong, the zygote will develop into baby in about 9 months. If the implantation is not strong, the embryo will be discarded from the mother's body. This condition is known as miscarriage.

Lukis rajah 4.19 dan 4.20 m/s 61 text book

C. Development of embryo

1. After the zygote attaches into the wall of the uterus, it is known as an embryo.
2. Following the process of implantation, a structure known as placenta is formed. The placenta joins the embryo to the mother's body via a special tube called the umbilical cord.
3. The functions of placenta:
   i. attaching the embryo to the wall of the mother's uterus.
   ii. Transporting and directing antibodies and hormones from the mother's body to the foetus.
   iii. Transporting nutrients (amino acid, vitamins, oxygen, fatty acid, glycerol and glucose) in the mother's blood to the foetus.
   iv. Acting as excretory organ to the foetus, that is excretory matters such as urea and carbon dioxide are excreted via the mother's blood.

D. Development of foetus

PRENATAL CARE

1. Prenatal care is important for a pregnant woman to ensure that both the expectant mother and the foetus are healthy.
2. A pregnant woman should take nutritious food for her own needs as well as for the growth and development of the foetus.
3. Apart from nutrients and oxygen, other substances, circulating in the expectant mother's blood such as alcohol, chemical in tobacco smoke and drugs can also pass through the placenta and be absorbed by the foetus.
4. Alcohol and chemical in tobacco smoke can cause a miscarriage and birth defects such as mental retardation.
5. Drug can cause brain damage or even kill the foetus.

THE IMPORTANCE OF RESEARCH IN HUMAN REPRODUCTION

http://www.babycentre.co.uk/refcap/4094.html

A. Sterility and ways to overcome sterility PMR 08

1. Sterility is the inability to reproduce.
2. A man may be sterile because his testes do not produce enough sperms, or his sperms may not be able to reach an ovum in the fallopian tube.
3. A woman may be sterile because she fails to ovulate or there is a blockage in her fallopian tube, preventing the ovum and sperm from fusing.
4. Taking nutritious food which is rich in vitamins E and minerals may help to overcome the problem of sterility.
5. Hormone treatment is used to increased sperm or egg production.
6. Surgery is used to correct problems such as blocked fallopian tubes or blocked sperm ducts.
7. In Vitro Fertilisation (IVF) can be used to help infertile couples conceive. In IVF, the eggs are mixed with sperms in culture dishes. Fertilisation occurs in the culture dishes. The culture dishes are incubated for a several days for the fertilised eggs to develop. The embryo is then inserted into the woman's uterus where implantation takes place.

B. Birth control or contraception PMR 07

1. The birth control methods prevents ovulation, fertilisation and implantation of fertilised ovum.
2. Preventing ovulation:
   a. Contraceptive pills contain the sex hormones of the women which prevent ovulation by changing the states in ovary.
3. Preventing fertilisation:
a. natural method - which also called the rhythm method does not use any contraceptive devices. Married couples avoid copulation during the fertile period.
b. Condom - is a thin rubber sheath worn over the penis to prevent sperm from entering the uterus during ejaculation.
c. Diaphragm - is a tin rubber cap fitted at the cervix of the woman to prevent sperm from entering the uterus.

4. preventing implantation of the fertilised ovum:
   a. intrauterine contraceptive device (IUCD) is inserted into the uterus to prevent the fertilised ovum from implanting in the uterine wall and prevent sperm from entering the uterus.

5. sterilisation is a permanent contraceptive method.

6. Ligation (tubectomy) - the cutting and tying of both the fallopian tubes of the woman so that the ovum cannot be fertilised by any sperm.

THE SEXUAL REPRODUCTIVE SYSTEM OF FLOWERING PLANTS.

A. the different parts of a flower. **PMR 04**

1. The parts and function of a flower are as follows:
   i. sepal - protects the flower at the bud stage.
   ii. petals - attracts insects for pollination.
   iii. stamen - the male reproductive organ.
   iv. filament - holds the anther
   v. anther - produces pollen
   vi. pollen grains - contain male gametes/male reproductive cell.
   vii. pistil - the female reproductive organ
   viii. stigma - receives pollen grains
   x. ovary - produces ovules
   ix. ovule - contains the female gamete/female reproductive cell.

B. The functions of the male and female reproductive parts of a flower in sexual reproduction.

1. The stamen and the pistil are the most important parts of a flower because they produce the gametes for sexual reproduction.
2. The function of the anther of a stamen is produce pollen grains.
3. The pollen grains contain male gametes.
Draw figure 4.25 & 4.26 page 70 text book

4. The function of filament is
   b. to hold the anther to a position so that pollen grains can be released effectively
   c. to supply the anther with nutrients and water

5. The stigma serves as a receptive surface for pollen grains. It has a sticky surface so as to enable pollen grains to stick to it more easily.

6. The ovary produces ovules. The ovules contain egg cells or female gametes.

POLLINATION

A. What is pollination? PMR 2009

1. The transfer of pollen grains from the anther to the stigma is known as pollination.
2. The plant resulting from cross-pollination is of better quality than the plant germinated from a seed from self-pollination, inherits the good characteristics of both parent plants compared with the plant from self-pollination which only possesses the qualities of only one parent plant.

B. Agents of pollination PMR 2009

1. Several types of pollinating agents such as water, wind or animal.
2. Aquatic plants like Hydrilla release pollen grains into the water to be floated to the stigma of another flower.
3. Plant that are pollinated by wind have an elongated style which hangs out of the petals and is light.
Table below show the pollination by wind and insects.

<table>
<thead>
<tr>
<th>special characteristics</th>
<th>pollination by wind</th>
<th>pollination by insect (bee &amp; butterfly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>size and colour of petals</td>
<td>small, dull-caloured and less attractive flower.</td>
<td>big, visible and scented flower. Petals are brightly-coloured to attract insect.</td>
</tr>
<tr>
<td>appearance of stamen</td>
<td>long stamen and usually sticks out of the petals.</td>
<td>short stamen and hidden within the petals.</td>
</tr>
<tr>
<td>appearance of anther</td>
<td>anther is usually big and sticks loosely at tip of filament.</td>
<td>Anther is usually small and sticks firmly at tip of filament.</td>
</tr>
<tr>
<td>appearance and texture of pollen</td>
<td>tiny, smooth and light pollen and is numerous.</td>
<td>big, coarse, spiky pollen and few in number.</td>
</tr>
<tr>
<td>appearance of style</td>
<td>long and hairy style.</td>
<td>short style and even stigma, lobed and sticky.</td>
</tr>
<tr>
<td>appearance of nectar</td>
<td>does not produce nectar.</td>
<td>produces sweet nectar.</td>
</tr>
<tr>
<td>examples of plants</td>
<td>maize, grass, paddy and wild grass.</td>
<td>rose, hibiscus, orchid and durian.</td>
</tr>
</tbody>
</table>

C. Type of pollination PMR 2009

http://www.czguest.com/docs/articles/summer_nyp/nyp

1. The process of pollination takes place in two ways:
   a. **self-pollination**
      
      pollen grains are transferred from one anther to the stigma of the same flower or another flower of the **same plant**.
      
      Draw figure 4.31 page 72

   b. **cross-pollination**
      
      pollen grains are transferred from one anther to the stigma of the same flower or another flower of the **same species**. (different plant)
      
      Draw figure 4.32 page 73
D. The Advantages of cross pollination

http://www.uwrf.edu~vd07/plant%20breeding.htm
http://hort.unl.edu/815/apmx.htm

1. Characteristics of a plant from a seed of cross-pollination are:
   a. short ripening period
   b. more resistant against disease and pest attacks
   c. quantity of fruit increases
   d. quality of plant is better

E. The use of cross pollination in agriculture.

<table>
<thead>
<tr>
<th>Bil</th>
<th>Uses</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To increase yield of crop</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>To obtain crops with better characteristics.</td>
<td>Draw table 4.2 page 74 text book</td>
</tr>
<tr>
<td>3</td>
<td>To obtain crops that are resistant to pests and diseases</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>To obtain crops that mature earlier.</td>
<td></td>
</tr>
</tbody>
</table>

THE DEVELOPMENT OF FRUITS AND SEEDS IN PLANTS

A. Fertilisation in plants

1. When a pollen grain lands on the stigma, it germinates and grows a pollen tube as shown below.

   Draw figure 4.33a page 76 text book

2. The germination of the pollen grain is stimulated by the sugary, sticky secretion on the surface of the stigma.

3. The pollen tube grows through the length of the style to reach the ovary.

4. The male gametes move down the pollen tube towards the ovary as shown below.

   Draw figure 4.33b page 76 text book
5. When the male gametes have reached the end of the pollen tube, a male gamete enters the ovule and fertilises the egg as shown below.

Draw figure 4.33c page 76 text book

6. A zygote is formed in the ovule.

Draw figure 4.33d page 76 text book

B. The formation of fruits and seeds

1. After fertilisation, the ovary develops into a fruit.
2. The zygote in the ovule develops into an embryo and the ovule becomes a seed as shown below.

Draw figure 4.34 page 77 text book

3. The fruit protects the seed during its development.
4. The other parts of the flowers, such as the petals, sepals, stigma and stamen will degenerate and drop off.

GERMINATION OF SEEDS

A. The different parts of a seed and their functions

1. A seed consists of the embryo and a seed coat or testa as shown below.

Draw figure 4.36 page 78 text book

2. The testa has a small hole called the micropyle.
3. The testa protects the seed.
4. The micropyle enables water and air to enter the seed.
5. The hilum is the part of the seed that attaches the seed to the fruit.
6. The embryo is made up of the plumule, radicle and cotyledon.
7. The embryo will develop into a seedling during germination.
8. The plumule is the part of the embryo that will develop into a shoot while the radicle will become a root.
9. The cotyledons of a dicotyledonous seed store food for use during germination.
10. In a monocotyledonous seed, food is stored in the endosperm.
B. The physical changes of a seed during germination

1. Germination is the growth of the embryo in a seed to become a seedling.
2. Once a seed germinates, many physical changes can be seen as shown below.

| Draw figure 4.37 page 79 text book |

3. First, the testa breaks. The radicle is the first part of the seedling to emerge from the testa.
4. The radicle grows downwards into the soil and lateral roots grow from it.
5. The plumule emerges from the cotyledons.
6. The shoot is bent to protect the plumule from damage.
7. The plumule grows upwards to form two leaves.
8. The cotyledons shrink and drop off as the food stored in them are used up.
9. The seedling is now able to make its own food by photosynthesis.

C. The condition needed for germination

1. Germination of seeds will only take place if there is sufficient
   a. water,
   b. air and
   c. suitable temperature.

APPLICATION OF VEGETATIVE REPRODUCTION IN FLOWERING PLANTS.

A. Vegetative reproduction

1. New plants grow from the vegetative parts of the parent plants, such as the roots, stems or leaves.
2. Flowering plants that reproduce vegetatively can be classified into three groups.

i. Plants that reproduce vegetatively by using their roots.

   1. These plants have roots that store food.
2. When the roots are detached from the parent plants, the roots can grow into new plants.

Draw photograph 4.13 page 82 text book

ii. Plants that reproduce vegetatively by using their leaves.

1. These plants have leaves that produce buds.
2. The buds can grow into new plants when the leaves are detached from the parent plant.

Draw photograph 4.14 page 82 text book

iii. Plants that reproduce vegetatively by using their stem.

1. These plants have modified stems that produce buds.
2. The buds on the stems can grow into new plants.
3. The modified stems are given special names such as runners, rhizomes, tuber and bulbs.

Draw photograph 4.15 & 4.16 page 82 & 83 text book

B. The application of research on vegetative reproduction in agriculture.

1. Plant tissue culture

Refers to the cultivation of plant tissues in a nutrient medium in the laboratory to produce new plants. Table 4.4 below gives some applications of plant tissue culture in agriculture.

Draw Table 4.4 page 85 text book

Draw figure 4.39 page 84 text book
2. Stem cutting

Another way to artificially propagate plants. In stem cutting, a new plant is produce by cutting off a portion of the stem of another plant. The cutting grows root and becomes a new plant.

THE END......good luck