

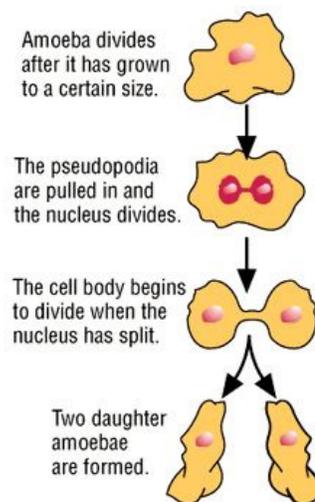
Unit 4: Animal Systems

Reproductive System

Biology 30
Mr. Oosterom

Asexual Reproduction

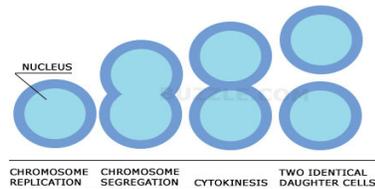
- Reproduction involving only one parent
- All offspring are genetically identical **clones** of their parent
- Advantages:
 - Many offspring can be produced in a short time
- Disadvantages:
 - Any negative effects on the parent, like disease or unfavourable environmental conditions, will also affect all of the offspring as well.



Types of Asexual Reproduction

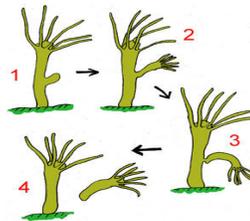
Binary Fission

- When single celled organisms divide into two identical daughter cells
- DNA replicates, then the cell grows inward and divides into two



Budding

- Parent produces a small bud, or miniaturized clone, that detaches and develops into a new organism



Types of Asexual Reproduction

Parthenogenesis

- Process by which unfertilized, haploid eggs mature into new organisms
- Common in social insects where the queen produces male drones, while fertilized eggs become female workers and queens

Spores

- Spores are haploid cells that can develop into new organisms
- Spores remain dormant until conditions are favourable
- Common in fungi, algae, some moulds and non-flowering plants like ferns.

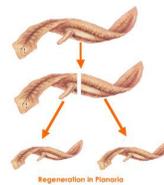
Types of Asexual Reproduction

Vegetative Reproduction

- Identical clones or offspring of plants are produced from the parent plant without seeds
- Examples:
 - Runners from strawberry or spider plants
 - Cuttings from a plant placed in water will grow roots
 - Rhizomes (underground runners) and bulbs produce new individuals

Fragmentation

- New organisms form from a piece of the existing parent organism
- Example
 - Piece of a starfish will grow into a new starfish



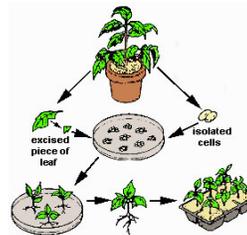
Types of Asexual Reproduction

Grafting

- Part of one plant is joined with another. Two plants heal together and grow as a single plant
- Common in apple trees grafted to produce two types of apples
- Also used to strengthen a plant stem

Plant Tissue Cultures

- Plant cells can be placed on a petri dish containing nutrients and chemicals and grown into new organisms
- New seedlings can then be planted into soil



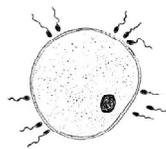
Asexual Reproduction and Agriculture

- ❑ Potatoes are great example of how asexual reproduction is use in agriculture in Saskatchewan.
- ❑ Parent plants with desirable characteristics are selected. Cuttings are taken from the plant and grown directly or used to make plant tissues.
- ❑ Seed potatoes are grown for replanting instead of eating.



Sexual Reproduction

- ❑ Humans reproduce by sexual reproduction.
- ❑ Sexual reproduction is the union of sex cells (**gametes**), **eggs** (ova) from the female and **sperm** from the male
- ❑ Union of gametes results in **fertilization**
- ❑ Sexual reproduction produces the variations by combining traits from both parents
- ❑ First Nations elders people teach that sexual reproduction bears sanctity because it produces life.
- ❑ It is viewed as healthy, sacred and a very natural means that enables living things to grow again



Internal vs. External Fertilization

Internal

- ❑ Sperm is deposited by the male directly into the female reproductive system to fertilize the egg
- ❑ Fertilization is guaranteed, so number of offspring is lower
- ❑ Development may be internal (humans) or external (reptiles / birds)
- ❑ Common in sharks and most land animals

External

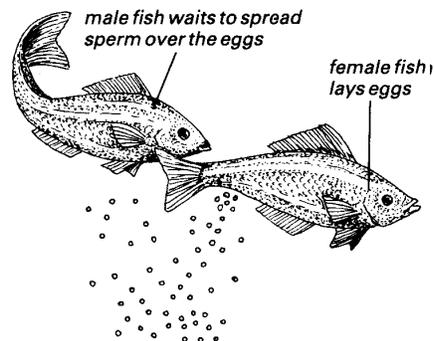
- ❑ Females release eggs into the open water or in clusters
- ❑ Male either deposits sperm directly onto the egg cluster or releases sperm into the water to fertilize any eggs that are present
- ❑ Development occurs in stages (metamorphosis)
- ❑ High numbers of egg and sperm produced to ensure fertilization
- ❑ Common in fish and amphibian

Internal vs. External Fertilization

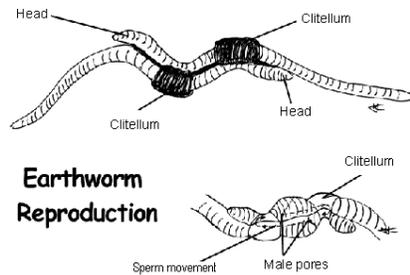
Internal



External



Earthworm fertilization



- Two worms line up against one another facing opposite directions.
- In this position, both worms excrete so much mucous, that what is called a slime tube forms around their bodies.
- Each worm ejaculates sperm from its sex organs into this slime tube and it is then deposited in the other worm's sperm receptacle.
- The act of mating is completed, but the process of reproduction still continues as each worm goes its separate way

The Human Reproductive System

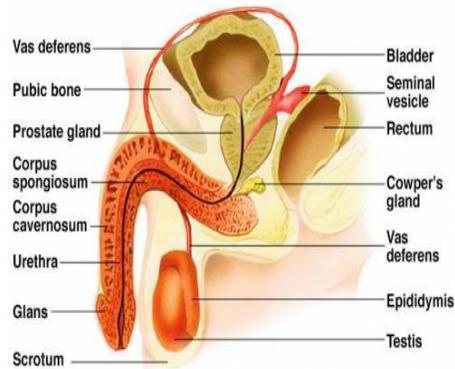
- Humans reproduce by sexual reproduction.
- Sexual reproduction produces the variations which are necessary for a species to maintain homeostasis or balance.
- As a species, humans have a high degree of variation and this variation has helped us to populate the entire planet.
- Our reproductive system is one of the main reasons why we have been so successful as a species.

The Male Reproductive System

- In males, the reproductive system begins to form when the fetus is eight weeks old and is fully functional at the end of puberty (around 13 years of age).
- Puberty is the stage when reproductive hormones are formed and reproductive development begins. Viable sperm are able to be produced by the end of puberty.
- The male reproductive system is made up of a number of parts, see Fig. 15.2, P. 487.
- Both the testes and penis are outside the body cavity of the male.

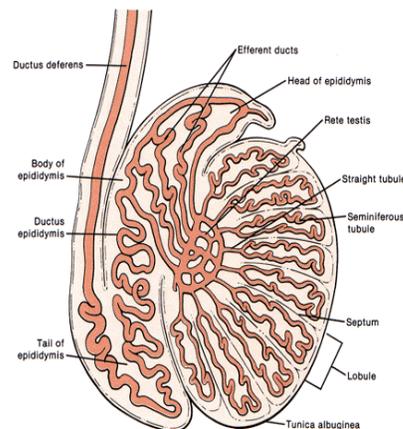
Hyde/Delaney: Understanding Human Sexuality, 6e. Copyright © 1997, The McGraw-Hill Companies, Inc. All Rights Reserved.

Male Sexual & Reproductive Organs



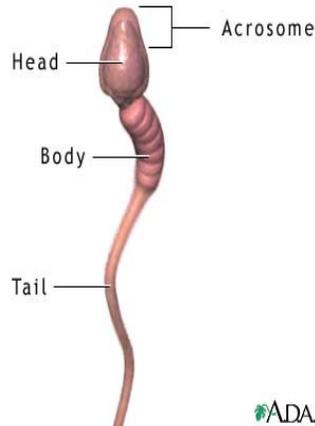
Male Reproductive System...

- The testes produces both sperm and reproductive hormones. They are formed inside the body, but descend into the scrotum during the last two months of fetal development.
- In the scrotum, the testes have a cooler temperature than the body cavity, by 2 - 3 degrees. This temperature difference is necessary for the sperm to develop properly
- The penis transfers sperm into the female reproductive system during sexual intercourse.
- The testes are made up of long, coiled tube: called the **seminiferous tubules** and these are surrounded by cells called **interstitial cells**.
{ See Fig. 15.3, P. 488 }
- Spermatogenesis, the production of sperm, occurs in the seminiferous tubules.



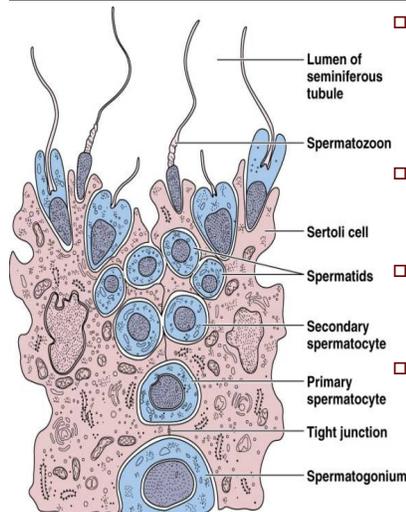
Sperm Production

- Within the seminiferous tubules, **sertoli cells**, support, regulate and nourish the developing sperm.
- Once formed, sperm move to the **epididymis** where they become mature and motile.
- During sexual arousal, the soft tissue of the penis fills with blood making the penis erect. The sperm then move out of the epididymis through a tube called the **sperm duct** or **vas deferens**.



ADAM.

Sperm & Semen Production



- As it moves through this duct, the sperm mixes with a fluid that is produced by three glands called:
 - Seminal vesicles
 - Prostate gland
 - Cowper's gland
- The seminal vesicles produce a mucus-like fluid which contains a sugar called fructose. Fructose is used to provide energy for the sperm.
- The prostate gland and the cowper's gland both secrete an alkaline fluid which is used to neutralize acids in the female's reproductive tract.
- The mixture of sperm and fluid is called **semen**. This mixture passes into a tube called the **urethra**. The urethra passes through the center of the penis and carries the semen to the outside of the male's body, a process called **ejaculation**.

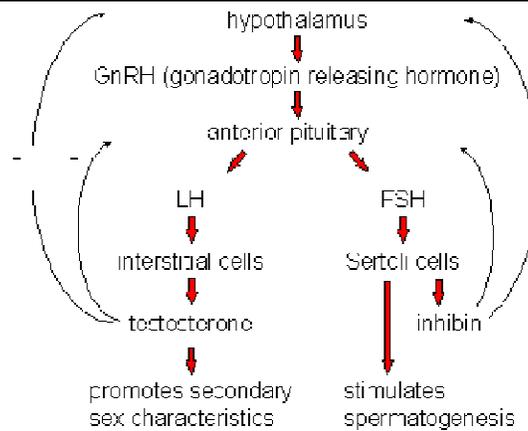
Male Reproductive Hormones

- There are several hormones involved in the male reproductive system.
 - Follicle stimulating hormone (FSH)
(named after its function in the female)
 - Inhibin
 - Luteinizing hormone (LH)
 - Testosterone

Regulation of Sperm Production

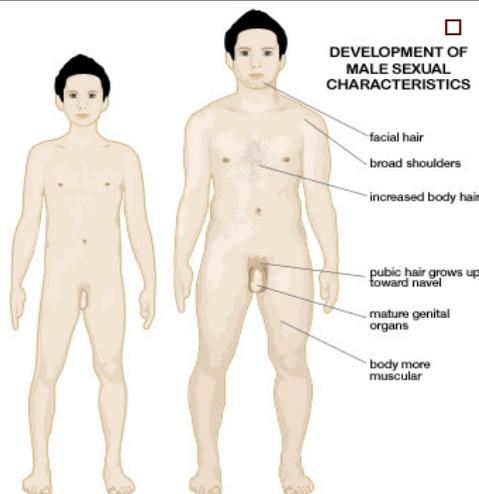
- FSH, which is produced by the anterior pituitary gland, **stimulates** the process of spermatogenesis in the testes.
- Inhibin is a hormone which is released by the seminiferous tubules. Inhibin works as a negative feedback loop on the hypothalamus. It **inhibits** the production of FSH by acting on the hypothalamus, slowing down sperm production
 - FSH and inhibin work together to control how quickly sperm are formed.
- LH, which is also produced by the anterior pituitary gland, stimulates the interstitial cells of the testes to produce the male sex hormones (androgens) such as testosterone.

Summary of Male Hormone Control



See page 489, Figure: 15.4

Function of Testosterone



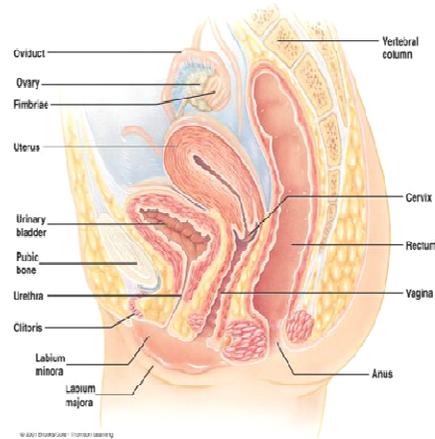
DEVELOPMENT OF MALE SEXUAL CHARACTERISTICS

Testosterone is the major male sex hormone and is responsible for the development of the male secondary sexual characteristics.

- Enlargement of the penis and testes.
- Enlargement of the larynx or Adam's apple.
- Promotes the development of muscle tissue over fat.
- Stimulates the growth of hair on the face, chest, under the arms, and around the genitals.

Female Reproductive System

- The female reproductive system is very different from the male system in both structure and function.
 - It produces the female reproductive cell or ovum.
 - It maintains a fertilized egg (zygote) through its development as an embryo and fetus.
 - It allows for the birth of a baby.
- There are a variety of parts which make up the female reproductive system, see Fig. 15.5, P. 490.



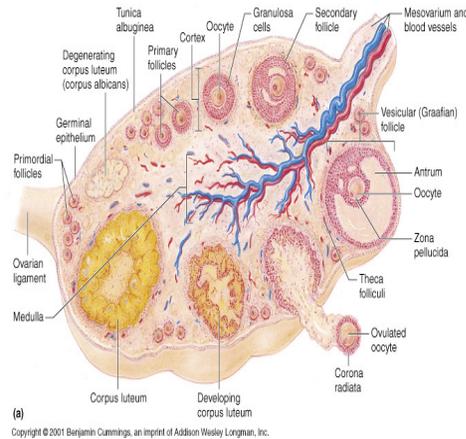
Female Reproductive Organs

- The **vagina** is an opening which allows the erect penis to enter the female during sexual intercourse. It is here that sperm are deposited inside the female. It also allows the fetus to exit the female during childbirth.
- At the end of the vagina is a narrowing called the **cervix**. This structure serves as both an entrance and exit to the uterus.
- Next is the **uterus** or **womb**. This is a thick walled muscular organ which is approximately the size of a fist.
 - During pregnancy it can expand to six times its usual size to accommodate the fetus. The inside of the uterus has a lining called the **endometrium**. This lining has a large number of blood vessels which provide nutrients to the developing fetus.



The Ovary – Ovum Production

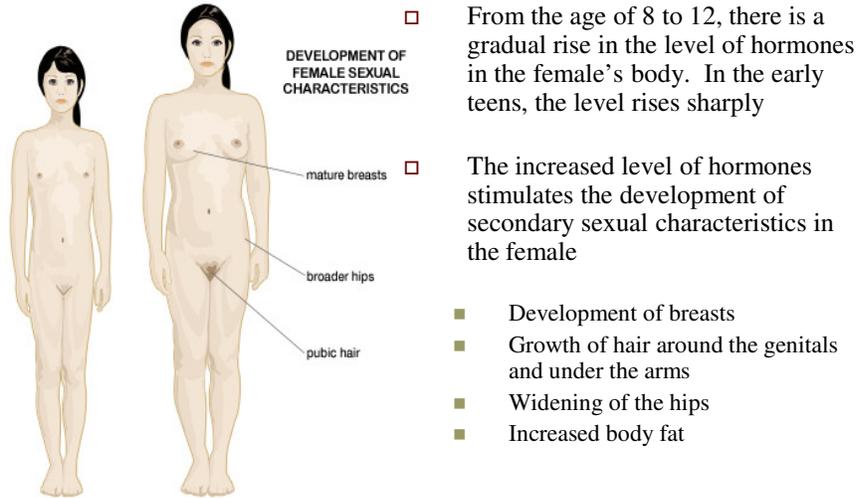
- The uterus is connected to the **ovaries** by tubes called the **oviducts** or **fallopian tubes**. The ovaries produce the **ova** or **eggs**. The oviducts transfer the ovum or egg from the ovary to the uterus.
- The egg is fertilized by a sperm inside the oviduct and is then pushed down to the uterus by cilia which are located on the inside of the oviduct.
- At the end of the oviduct, near the ovary, there are a number of finger-like projections called **fimbriae**. These structures lightly massage the ovary to stimulate it to release the egg. Once released, the egg is drawn into the oviduct by the fimbriae



Female Reproductive Hormones

- Puberty in females begins earlier than in boys. In North America, girls enter puberty around the age of nine or ten. It is later in some countries. There have been reported cases of girls beginning puberty at three years of age.
- The onset of puberty is directly linked to diet. Girls who have a healthy diet tend to enter puberty at an earlier age while those who have a poor diet enter at a later age.
- As well, scientists are investigating a variety of social and environmental factors which make affect the age of puberty.
- Puberty is triggered by the hypothalamus. This structure releases chemicals that begin the production of reproductive hormones.
- Like males, females have a number of hormones:
 - Follicle Stimulating Hormone (FSH)
 - Luteinizing Hormone (LH)
 - Estrogen
 - Progesterone

Female Secondary Sex Characteristics



The Menstrual Cycle

- The reproductive hormones follow a cyclical pattern called the **menstrual cycle**.
 - This cycle usually lasts around 28 days, but can vary in length from 20 to 45 days. It can also differ in its starting time from month to month.
- The menstrual cycle is also controlled by the hypothalamus. The hypothalamus releases chemicals which stimulate the anterior pituitary gland to release two hormones → FSH and LH.
 - These hormones play a major role in stimulating the release of **follicles** which are groups of cells that contain the ovum or egg.

Menstrual Cycle...

- ❑ Women are born with over 2 million follicles, but will only release around 400 during her reproductive life.
- ❑ The menstrual cycle occurs in four stages
 1. Follicular stage
 2. Ovulation
 3. Luteal stage
 4. Menstruation

1. Follicular Stage

- ❑ The initial stage of the menstrual cycle.
- ❑ An increase in the level of FSH stimulates the follicles to release high levels of estrogen into the bloodstream.
- ❑ The estrogen stimulates the endometrium of the uterus to thicken and also causes an increased blood supply to the endometrium in preparation for a possible pregnancy.
- ❑ As estrogen increases it causes a decrease in the amount of FSH being produced from the anterior pituitary gland (negative feedback loop). It also causes the hypothalamus to release large amounts of LH which will trigger a follicle to release of an ovum

2. Ovulation

- ❑ Takes place at the midpoint in the cycle, after about 14 days
- ❑ The ovum is released from the ovary into the oviduct. After the egg is released, the empty follicle changes into a structure called the **corpus luteum**.
- ❑ The corpus luteum is a group of cells which produce the hormone **progesterone**.

3. Luteal Stage

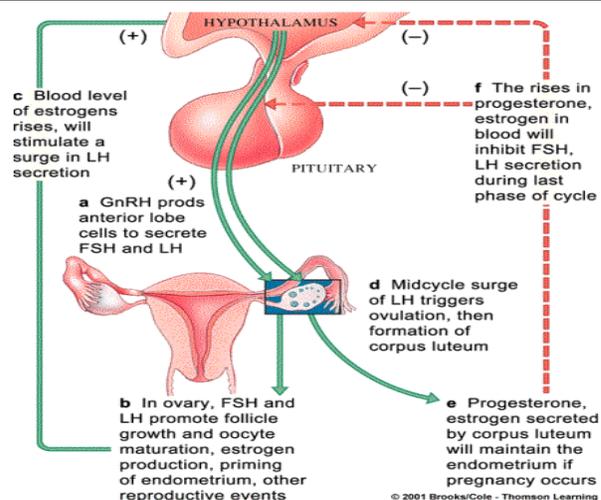
- ❑ In this stage, LH stimulates the corpus luteum to produce the hormone progesterone.
- ❑ Progesterone inhibits the development of any other follicles and this makes sure that only one ovum (egg) is released during the menstrual cycle.
- ❑ Progesterone also inhibits the production of LH. Causing LH levels to decrease as progesterone increases
- ❑ Eventually the corpus luteum breaks down and the luteal stage ends

4. Menstruation

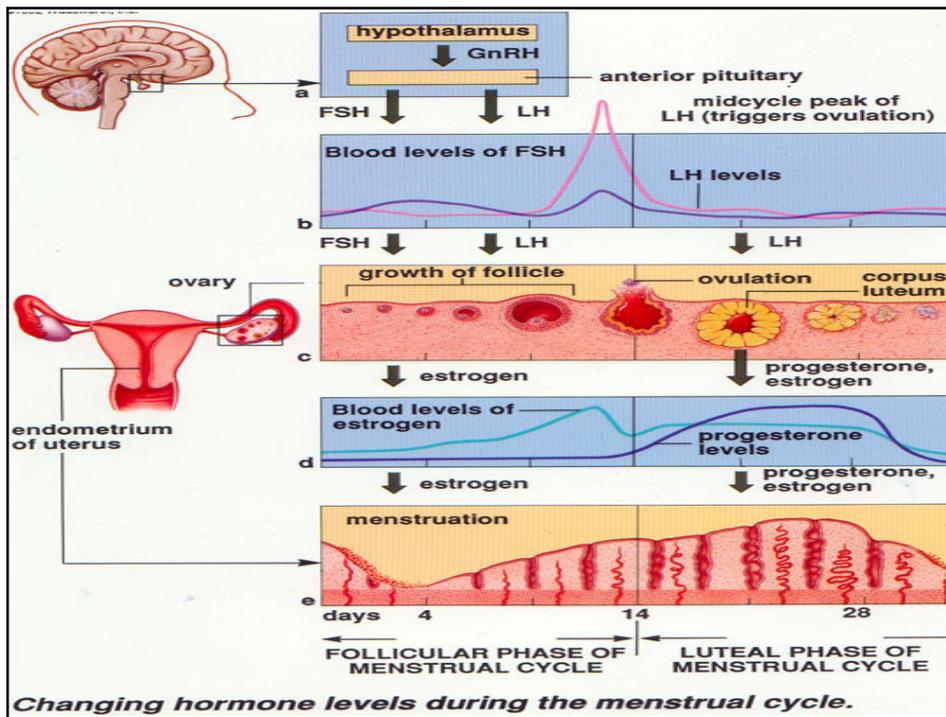
- ❑ As the progesterone level decreases, the blood supply to the endometrium of the uterus also decreases.
- ❑ The endometrium breaks down
- ❑ Blood vessels in the endometrium rupture
- ❑ Tissues and blood flow out of the vagina

- ❑ As menstruation begins, the first stage of the menstrual cycle (follicular stage) begins once again

Hormone Control of the Menstrual Cycle



Also see figure on page 492 in your book



Female Hormone Treatments

- As a woman ages there is a decrease in the hormones which are produced in her body. As the hormone level decreases, the female's body stops going through the menstrual cycle, we call this **menopause**.
- Both during and after menopause, the female's body goes through a series of changes
 - A rise in cholesterol level
 - A decrease in bone mass
 - Constricting and dilating of blood vessels to produce what we call hot flashes
 - Mood changes
- **Hormone replacement therapy** - Doctors will prescribe low levels of estrogen and progesterone hormones to lessen the effect of these changes

Hormone Replacement Therapy

There are both positive benefits and negative side-effects of this therapy

The positive benefits include:

- ❑ Relief of menopausal symptoms such as hot flashes, night sweats and sleep disturbance
- ❑ Prevention of bone loss (osteoporosis)
- ❑ Improved memory
- ❑ Decrease in urinary infections
- ❑ Decrease in macular degeneration.

The negative side-effects include:

- ❑ Irregular vaginal bleeding
- ❑ Stomach upset
- ❑ Severe headaches
- ❑ Formation of blood clots
- ❑ Increased risk of breast cancer
- ❑ Increased risk of uterine cancer
- ❑ Edema (water retention)
- ❑ Increased risk of heart attack
- ❑ Fluctuations of blood sugar level

Reproductive Control

- ❑ The use of technology to control reproduction is a highly controversial topic.
- ❑ This technology can be divided into two categories:
 1. Technologies that enhance reproductive potential.
 2. Technologies that reduce reproductive potential.



Fertility drugs



Birth control pills

Infertility

- Couples who are unable to have any children are called **sterile** while those couples who have fewer children than they want to are called **infertile**

- A woman may be sterile or infertile for a number of reasons including:
 - Blocked oviducts
 - Failure to ovulate
 - Endometriosis, a condition in which the endometrium grows outside the uterus.
 - Damaged eggs

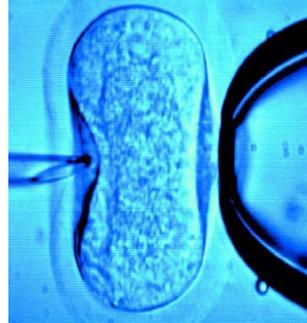
Infertility Continued

- A man may be sterile or infertile for a number of reasons including:
 - Obstructions in the vas deferens or epididymis.
 - Low sperm count.
 - A high level of abnormal sperm



Technological Solutions to Infertility

- Scientists have developed a number of ways to help infertile couples to have children, these include:
 - Artificial insemination (AI)
 - In vitro fertilization (IVF)
 - In vitro maturation (IVM)
 - Superovulation
 - Surrogate motherhood
 - Cryopreservation



See Table 15.1, P. 501

Controlling Reproduction

- There are also a number of technologies which can be used to reduce the chance of a woman becoming pregnant.
- The intentional prevention of conception is called contraception or birth control.

Some Methods of Birth Control

- Abstinence
- Vasectomy
- Birth control pills
- Tubal ligation
- The needle (Depo - Provera)
- Contraceptive implant (Norplant)
- Interuterine device (IUD)
- Diaphragm
- Cervical cap
- Male condom
- Female condom
- Spermicidal jelly and foam
- Rhythm method



KNOW TABLE 15.2 ON PAGE 502

Emergency Contraception

- This refers to medication which is taken after unprotected sexual intercourse to prevent pregnancy.
- The most common type of emergency contraception is the morning after pill.
- It can be taken up to three days after unprotected sex, but the sooner it is taken, the more chance of success.
- This pill will prevent pregnancy in two ways:
 1. High doses of estrogen and progesterone in the pill disrupts the uterine cycle and this prevents or delays the release of an oocyte from the ovary.
 2. If fertilization has already occurred, the embryo is prevented from implanting itself in the endometrium.
- Side effects from taking the morning after pill include nausea and vomiting.

Development & Differentiation

Fertilization & Implantation I

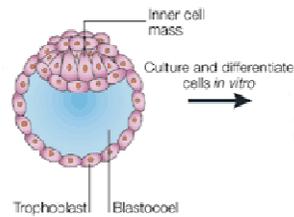
- Fertilization is the first stage of development which occurs when a sperm joins with an egg to form a **zygote** (fertilized egg).
- Only one sperm enters an egg. After the sperm enters the egg, the egg is stimulated to develop an impenetrable coating around it to prevent other sperm from entering.
- Fertilization occurs in the oviduct (fallopian tube) and once it is formed the zygote travels down the length of the oviduct and into the uterus or womb

Fertilization & Implantation II

- After it is formed the zygote goes through a series of cell divisions which we call **cleavage**.
- All of the cells which are produced from the cleavage process are identical and we call this group of identical cells a **morula**.
- From the time a zygote is formed, until it begins to differentiate, we call an organism an **embryo**.

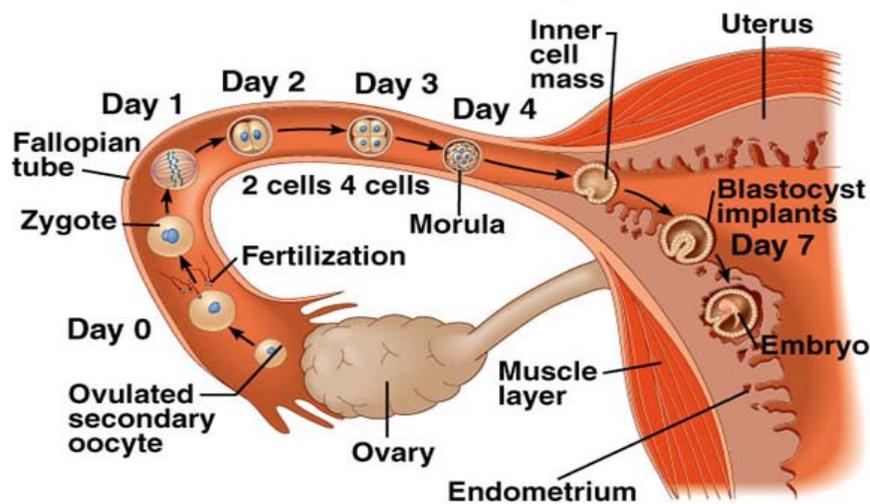
Fertilization & Implantation II

- By the time the embryo reaches the uterus it has formed into a hollow ball of cells called a **blastocyst**. The inner portion of the blastocyst contains a group of cells called the **inner cell mass**, this group of cells will develop into a **fetus** (baby). The outer portion of the blastocyst contains a layer of cells called the **trophoblast**. The trophoblast develops into membranes such as the amniotic sac which will nourish and protect the developing embryo.
- At the end of the first week of pregnancy, the embryo attaches itself to the endometrium of the uterus, a process called **implantation**.



Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

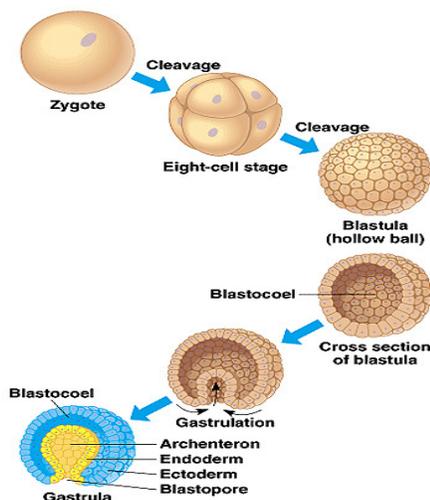
From ovulation to implantation



Implantation

- After implantation, the cells of the trophoblast secrete a hormone called **human chorionic gonadotropin** (HCG). This hormone keeps the corpus luteum from dissolving.
- The corpus luteum continues to produce the hormone progesterone which keeps the endometrium thick and rich in blood, preventing menstruation.

Embryonic Development

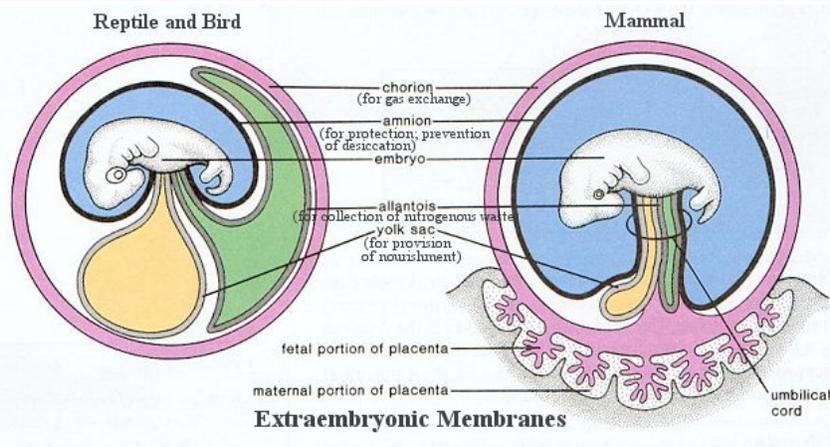


- During the first week of its development, an embryo's cells are identical to each other. However, during the second week the cells begin to differentiate or specialize.
- This process of cell differentiation is called **gastrulation**. At this stage, the embryo is called a **gastrula**.
- During gastrulation, the embryo's cells develop into three distinct layers which include
 1. Ectoderm
 2. Mesoderm
 3. Endoderm
- The cells in each of these layers are different from each other and each layer will eventually develop into different parts of the body. See Fig. 15.14, Pg. 508

Primary Membranes

- Humans, like most other animals, go through the embryonic stages of zygote, morula, blastocyst, and gastrula.
- The primary membranes are not part of the actual embryo. They are used to support, nourish and protect the embryo.
- The primary membranes in a human are very similar to those in a chicken embryo, See Fig. 15.15, P. 509.
- The four primary membranes include:
 1. **Chorion** – Develops into the placenta
 2. **Amnion** – contains amniotic fluid that helps to cushion the developing embryo
 3. **Allantois** – Used to collect waste
 4. **Yolk or Yolk sac** – the site of first blood cell formation. In many species it provides a nutrient source for the embryo (ie. chicks)

Primary Membranes

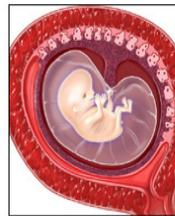


Differentiation

- Eventually, the three cell layers of the gastrula develop into different parts of the body, this is called **differentiation**.
- Over a period of 38 weeks, a tiny clump of identical cells develop into a human being with fully formed tissues and organs.
- The 38 weeks are divided into three time periods called **trimesters**. These are called the first, second, and third trimesters. Each trimester lasts about 3 months.

First Trimester (Weeks 1 - 12)

- During this first stage a number of things develop in the embryo.
- At the end of 3 weeks, the embryo is called a **neurula**. At this stage the embryo has the beginnings of a nervous system.
- At the end of 4 weeks, the limbs, eyes and spine begin to form.
- At 8 to 9 weeks, the first bone cells begin to form. The organism is known as a **fetus** at this stage.
- At 12 weeks, all of the major organs have started to form including ; the liver, stomach, brain, and heart. As well, a noticeable head and limbs have developed.
- The fetus is only 100 mm long at the end of this stage.



2nd month (8 weeks)



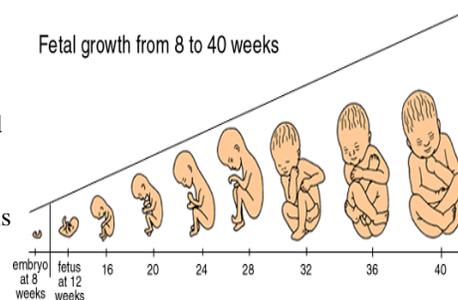
Second Trimester (Weeks 13 - 24)

- ❑ In this stage, the fetus develops an audible heartbeat.
- ❑ The skeleton begins to form.
- ❑ The brain and the nervous system develop further.
- ❑ The limbs continue to develop.
- ❑ At the end of 24 weeks, most of a fetus organs have developed.
- ❑ The fetus is 300 mm long after 24 weeks.



Third Trimester (Weeks 25 - 38)

- ❑ In the third trimester, the fetus size increases quickly.
- ❑ The immune system develops.
- ❑ The brain continues to grow and develop.
- ❑ The fetus opens its eyes at the end of the eighth month.
- ❑ At the end of 9 months, the fetus is around 525 mm long and weighs about 3.38 kg.



The Placenta & Umbilical Cord

- The placenta and umbilical cord provide the developing fetus with nourishment, oxygen and waste removal.
- The placenta is a thick membrane filled with blood vessels. It is formed from the chorion membrane. The placenta produces progesterone and estrogen. These hormones prevent any new follicles from maturing and keeps the endometrium thick and filled with blood. The placenta helps to provide nutrients and oxygen to the fetus and removes wastes.
- The umbilical cord is a tube which connects the fetus to the placenta.
- Since the mother's and fetus blood never mix, the placenta is very important in the diffusion of materials between the bloods of the mother and fetus

Effects of Teratogens on Development



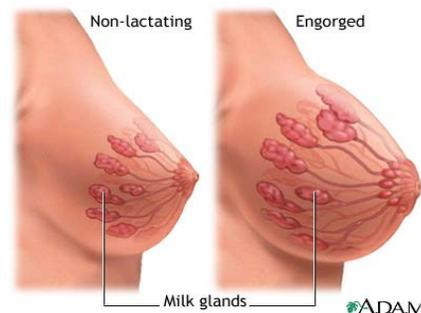
- A pregnant mother transfers both beneficial and harmful substances to the fetus.
- Many harmful substances can affect the normal development of the fetus. Substances which can cause a structural abnormality to a fetus during pregnancy are called **teratogens**.
- Examples of teratogens include:
 - Cigarette smoke
 - Alcohol
 - Prescription & Over the counter drugs
 - Radiation (X-rays, etc.)
 - Pollutants

Birth

- The birth process is triggered by a number of hormones such as:
 - Progesterone
 - Estrogen
 - Prostaglandins
 - Oxytocin
- The prostaglandins and oxytocin cause the uterus to contract. Contractions are the beginning of labour.
- Terms to know:
 - Breeched birth – baby delivered buttocks first
 - Caesarean section – baby delivered via an abdominal incision
- 3 stages of birth See page 513
 - Dilation stage
 - Expulsion stage
 - Placental stage

Lactation

- Lactation is the formation and secretion of breast milk from the pregnant mother.
- This process is controlled by hormones.
- Prolactin is the hormone which controls the production of milk in a pregnant female.
- Initially, the breasts secrete a thin, yellowish fluid called **colostrum**, but eventually they secrete milk for the baby.





The Suckling Reflex

- A suckling baby will stimulate the release of milk from the female's mammary glands.

- It occurs in five stages:
 1. Suckling stimulates nerve endings in the nipple and areola of the breast.
 2. Nerves carry the stimulus to the hypothalamus.
 3. The hypothalamus produces oxytocin which is released by the posterior pituitary gland.
 4. Oxytocin causes the mammary lobules to contract.
 5. Milk letdown (release of milk) occurs.