UNIT 21

DEVELOPMENT AND AGING

KEY CONCEPTS

21.1 Embryonic development
21.2 Control of development
21.3 Human embryonic development
21.4 Human birth and nursing
21.5 Disorders during embryonic development
21.6 Postnatal development
21.7 Aging

In the course of its life an organism changes from a fertilized egg into an adult. This process of conversion from simpler to more complex form is called development. As development proceed all sort of changes take place. The most obvious change is growth. However, these positive changes become negative at some stage in the life cycle, which are termed as aging.

21.1 EMBRYONIC DEVELOPMENT

The progressive changes which are undergone before an organism acquires its adult like form constitute the embryonic development. It begins with a series of mitotic divisions in the zygote. These early divisions of the zygote are called **cleavages**.

21.1.1 Early cleavages & blastocyst formation:

Cleavage is a period of fairly rapid mitotic divisions of the zygote following fertilization. Some 36 hours after fertilization, the first cleavage division has produced two identical cells called **blastomeres**. These divide to produce four cells, then eight, and so on. As a result, a loose collection of cells that form a berry-shaped cluster of 16 or more cells called the **morula** has been formed.

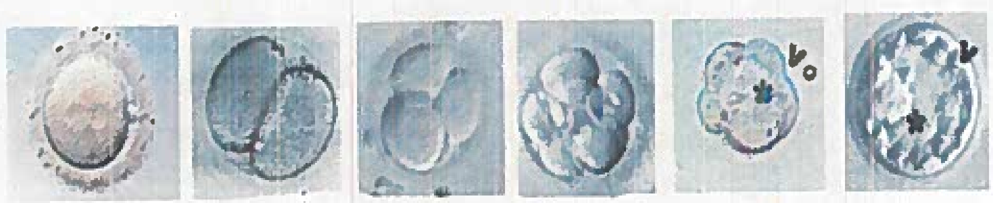

Fig: 21.1 Early cleavages & blastocyst formation.

All the while, transport of the embryo toward the uterus continues. By day 3 or 4 after fertilization, the embryo consists of about 100 cells and floats free in the uterus. By this time, it has tightened its connections between neighboring cells (a process called compaction) and begins accumulating fluid within an internal cavity. The zona pellucid the external membrane now starts to break down and the inner structure, now called a **blastocyst**, "hatches" from it. The blastocyst is a fluid-filled hollow sphere composed of a single layer of large, flattened cells called **trophoblast** cells and a small cluster of 20 to 30 rounded cells, called the **inner cell mass**, located at one side.

Trophoblast cells begin to display L-selectin (adhesion) molecules on their surface soon after the blastocyst hatching. They also take part in placenta formation, and secrete and display several factors with immunosuppressive effects that protect the trophoblast (hence the developing embryo) from attack by the mother's cells. The inner cell mass becomes the embryonic disc, which forms the embryo proper (and the extra embryonic membranes except the chorion, a trophoblast derivative).

21.1.2 Implantation of early embryo

The extra embryonic membranes that form during the first two to three weeks of development include the amnion; yolk sac, allantois, and chorion. The amnion develops when cells of the epiblast fashion themselves into a transparent membranous sac. This sac, the amnion, becomes filled with amniotic fluid.

Later, as the embryonic disc curves to form the tubular body, the amnion curves with it. Eventually, the sac extends all the way around the embryo, broken only by the umbilical cord.

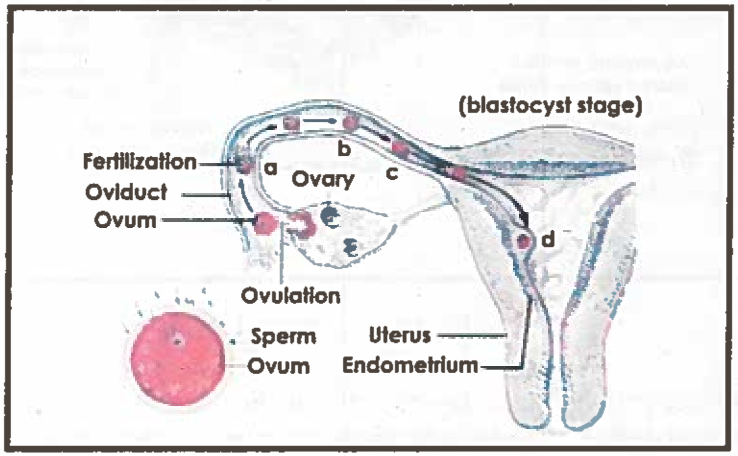

Fig: 21.2 Implantation of early embryo.

21.1.3 Gastrulation:

During week 3, the two-layered embryonic disc transforms into a three-layered embryo in which the primary germ layers—ectoderm, mesoderm, and endoderm present. This process, called gastrulation, involves cellular rearrangements and migrations. Gastrulation begins when a groove with raised edges called the **primitive streak** appears on the dorsal surface of the embryonic disc and establishes the longitudinal axis of the embryo.

Surface (epiblast) cells of the embryonic disc then migrate medially across other cells and enter the primitive streak. The first cells to enter the groove displace the hypoblast cells of the yolk sac and form the most inferior germ layer, the endoderm. Those that follow push laterally between the cells at the upper and lower surfaces, forming the mesoderm.

The cells that remain on the embryo's dorsal surface are the ectoderm. The mesodermal cells immediately beneath the early primitive streak aggregate, forming a rod of mesodermal cells called the notochord, the first axial support of the embryo. At this point, the embryo is about 2 mm long.

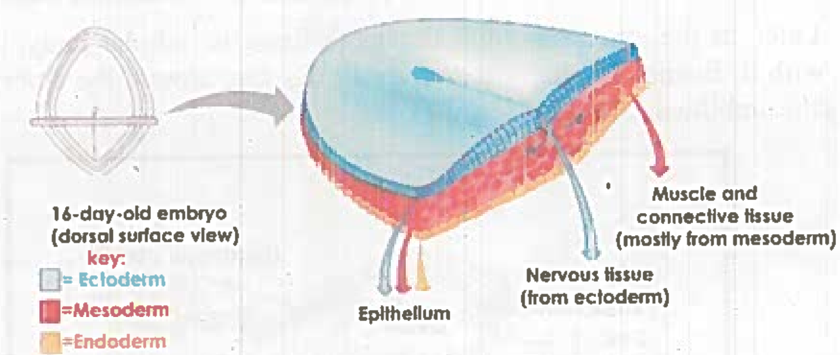

Fig: 21.3 Three germinal layers

The three primary germ layers serve as the primitive tissues from which all body organs will derive. Ectoderm fashions structures of the nervous system and the skin epidermis. Endoderm forms the epithelial linings of the digestive, respiratory, and urogenital systems, and associated glands. Mesoderm forms virtually everything else.

Gastrulation lays down the basic structural framework of the embryo and sets the stage for the rearrangements of organogenesis, formation of body organs and organ systems.

21.1.4 Neurulation:

For Your Information

By the end of the embryonic period, when the embryo is about 22 mm (slightly less than 1 inch) long from head to buttocks (referred to as the crown-rump measurement), all the adult organ systems are recognizable. It is truly amazing how much organogenesis occurs in such a short time in such a small amount of living matter.

The formation of organs and systems during embryonic development is called organogenesis. The first major event in organogenesis is neurulation, the differentiation of ectoderm that produces the brain and spinal cord. This process is induced by chemical signals from the notochord, the rod of mesoderm that defines the body axis.

The ectoderm overlying the notochord thickens, forming the neural plate, and then starts to fold inward as a neural groove, which forms prominent neural folds as it deepens. By day 22, the superior margins of the neural folds fuse forming a neural tube. It soon pinches off and becomes covered by surface ectoderm.

The anterior end of the neural tube becomes the brain and the rest becomes the spinal cord. The associated neural crest cells migrate widely and give rise to the cranial, spinal, and sympathetic ganglia (and associated nerves), to the medulla of the adrenal gland, and to pigment cells, and contribute to some connective tissues.

By the end of the first month of development, the three primary brain vesicles (fore-, mid-, and hindbrain) are obvious. By the end of the second month, all brain flexures are evident; the cerebral hemispheres cover the top of the brain

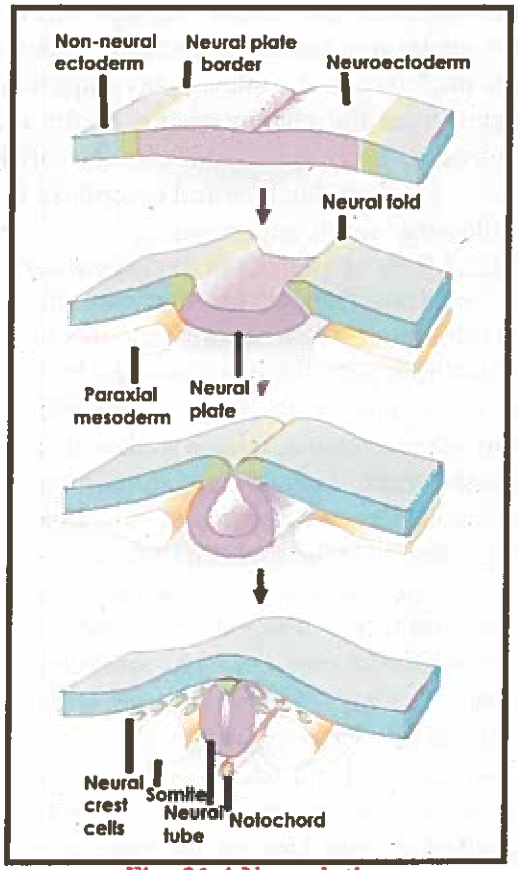

Fig: 21.4 Neurulation

stem, and brain waves can be recorded. Most of the remaining ectoderm forming the surface layer of the embryonic body differentiates into the epidermis of the skin.

21.2 CONTROL OF DEVELOPMENT

We know that every gene is present in every cell of developing embryo. Mitosis guarantees that every daughter cell of the zygote will have full set of chromosomes with all of their genes. As the development proceeds further, we find that different cells differentiate along different lines and perform different functions. For example, one enzyme produced by the cells of stomach is useful in digestion of food. Another enzyme produced in the cell of fingers and toes forms the protein keratin of the finger nails and toe nails. We are quite sure that the genes governing the production of both these enzymes are present in the cells of stomach and those of the fingers and toes. Why one kind of cells forms one sort of enzyme while the other kind of cells forms a different enzyme? The most logical answer to this question is that if the nuclei are identical in these cells then perhaps the cytoplasm may vary. Thus both the nucleus and cytoplasm play important role in normal development. The nucleus determines the characteristics of the individual, while the cytoplasm selectively "turns on" some genes and "switches off" others.

Role of nucleus and cytoplasm in development is shown with the help of the following simple experiments.

21.2.1 Role of nucleus in development

Importance of nucleus in development was expressed in a unicellular alga, the *Acetabularia*. It is 2 to 3 inches in length, inhabits European seawater. It has a stalk with a characteristic cap and base containing nucleus. The two species of this alga are different in the shape of their cap.

Acetabularia mediterranea has umbrella shaped cap, while *Acetabularia crenulata* has irregular head. The caps of both species were cut and thrown away. Their stalks were also removed but exchanged. i.e. the stalk of *Acetabularia crenulata* was grafted on the base of *Acetebularia mediterranea*

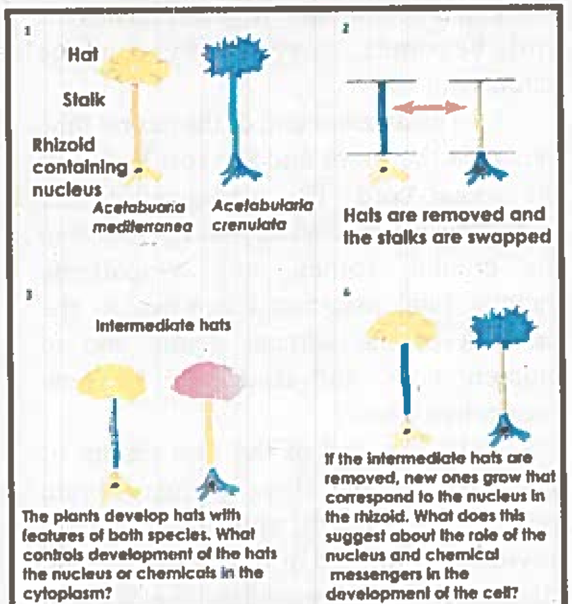

Fig: 21.5 Role of nucleus in development exhibited in *Acetabularia* and vice versa. A whole new alga forms from the jointed pieces. It was found that the new caps regenerated according to the type of nucleus present in the base. The nucleus exerts a strong influence on the development of cap through the messenger RNA. This is the evidence for nuclear control in developmental process.

21.2.2 Role of cytoplasm:

The gray crescent is the cytoplasmic director of cell destiny. This experiment demonstrates that the cytoplasm in the crescent -shaped gray area of a fertilized frog zygote helps direct embryonic development. Normal cleavage divides the zygote through the gray crescent, so each daughter cell receives an equal share of the components in the cytoplasm. If these two cells are experimentally separated, each grows into a normal tadpole. However, if the first division is altered so it doesn't bisect the gray crescent equally, only the cell containing the gray crescent develops normally and the one lacking gray crescent develops into an undifferentiated ball of cells. It is known that different cytoplasmic components contain different morphogenetic determinant that are responsible for cell differentiation.

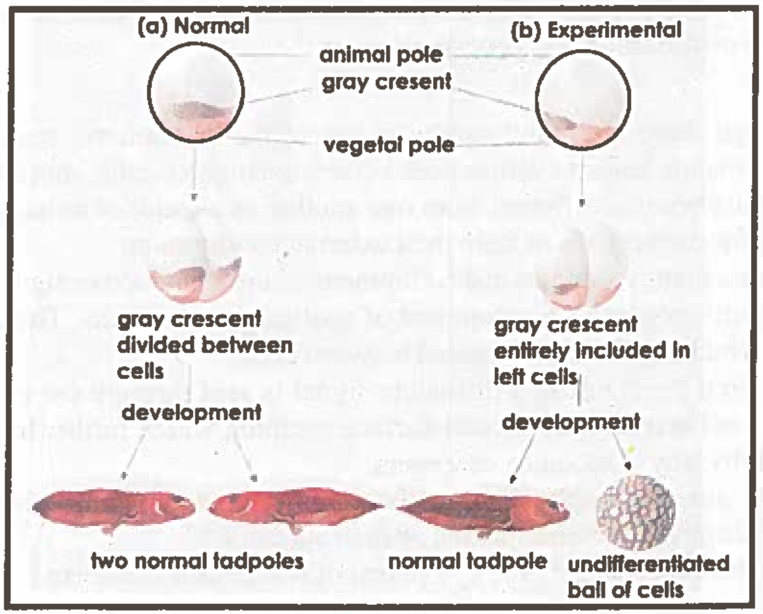

Fig: 21.6 Role of cytoplasm in development.

These determinants are present in blastomeres. For example the fertilized egg of an ascidian contains cytoplasm of four different colors that are segregated into different blastomeres.

- **Clear cytoplasm:** produces larval epidermis.
- **Yellow cytoplasm:** gives rise to muscle cells
- **Grey vegetal cytoplasm:** gives rise to gut
- **Grey equatorial cytoplasm:** produces notochord and neural tube.

23.2.3 Mechanisms of cellular determination

How do cells become different from their parent cells? How do two identical daughter cells become different from one another? How might one daughter cell become a neuron, while the other daughter cell becomes a skin cell? In some cases, determination results from the **asymmetric segregation of cellular determinants.** However, in most cases, determination is the result of **inductive signaling between cells.**

Asymmetric segregation of cellular determinants is based on the asymmetric localization of cytoplasmic molecules (usually proteins or mRNAs) within a cell before it divides. During cell division, one daughter cell receives most or all of the localized molecules, while the other daughter cell receives less (or none) of these molecules. This results in two different daughter cells, which then take on different cell fates based on differences in gene expression.

Induction:

Although there are many examples where the asymmetric segregation of cellular determinants leads to differences between daughter cells, more frequently we find that cells become different from one another as a result of inductive signals coming either from other cells or from their external environment.

There are many examples in development where an inductive signal from one group of cells influences the development of another group of cells. There are three main ways in which signals can be passed between cells.

- In the first mechanism, a diffusible signal is sent through the extracellular space, and is received by a cell-surface receptor, which further transmits the signals by way of second messengers.
- In the second mechanism, cells directly contact each other through transmembrane proteins located on their surfaces.
- In the third mechanism, the cytoplasm of two cells is connected through gap junctions, allowing the signal to pass directly from one cell to another cell. In plants, direct connections between cells are called plasmodesmata.

In the 1920s, the German zoologists Hans Spemann and Hilde Mangold discovered in an early gastrula an extremely important morphogenetic field with amazing properties. Their experiments involved dissecting a small piece of tissue from the dorsal lip of the blastopore in an early gastrula of a newt and transplanting it to the opposite side of another gastrula.

The result was the formation of a second notochord and neural tube during gastrulation and neurulation in the host embryo, and ultimately the formation of an entirely new body axis—the resulting embryo developed two bodies.

Though technically difficult because the gastrulas were only about 2 mm wide, these experiments yielded clear results because the researchers used two very closely related species of newts.

Triton taeniatus, which is pigmented, served as the tissue donor, and *Triton cristatus*, which is nonpigmented, served as the host embryo. By transplanting pigmented tissue from the donor embryo into a nonpigmented host embryo, Spemann and Mangold were able to visually track the origin of the newly developed tissue.

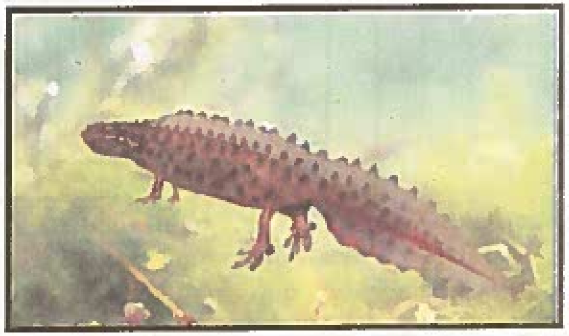

Fig: 21.7 *Triton*

The results showed that the secondary notochord and neural tube were composed in large part of host (nonpigmented) cells, with some pigmented cells remaining from the transplanted tissue. This indicated that the transplanted tissue—which they named the organizer—had induced cells in the host to differentiate into neural tissue on the transplanted side of the embryo. More recent work has shown that the organizer secretes morphogens.

21.3 HUMAN EMBRYONIC DEVELOPMENT

A normal pregnancy lasts nine months. Each three-month period of pregnancy is called a trimester. During each trimester, the fetus grows and develops.

21.3.1 Fetal development: The first trimester; week one to twelve

Soon after fertilization, the zygote travels down the fallopian tube toward the uterus. At the same time, it will begin dividing rapidly to form a cluster of cells resembling a tiny raspberry. The inner group of cells will become the embryo. The outer group of cells will become the membranes that nourish and protect it.

Implantation takes place in the fourth week of pregnancy. By the time it reaches the uterus, the rapidly dividing ball of cells — now known as a blastocyst — has separated into two sections. The inner group of cells will become the embryo. The outer group of cells will become the membranes that nourish and protect it. On contact, it will burrow into the uterine wall for nourishment. This process is called implantation. The placenta, which will nourish the foetus throughout the pregnancy, also begins to form.

The fifth week of pregnancy marks the beginning of the embryonic period. This is when the baby's brain, spinal cord, heart and other organs begin to form.

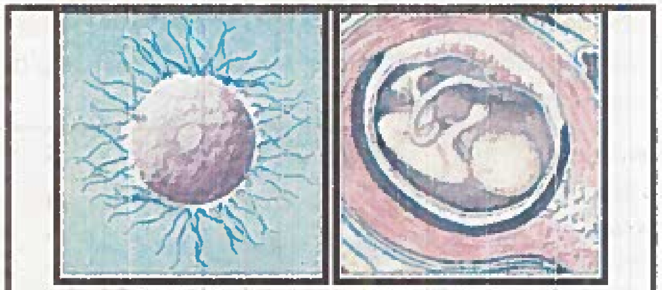

Fig: 21.8 First trimester

The embryo is now made of three layers. The top layer — the ectoderm — will give rise to the baby's outermost layer of skin, central and peripheral nervous systems, eyes, inner ear, and many connective tissues. Now baby's heart and a primitive circulatory system will form in the middle layer of cells — the mesoderm. This layer of cells will also serve as the foundation for the baby's bones, muscles, kidneys and much of the reproductive system.

Growth is rapid in coming weeks. The neural tube along fetal back is closing and heart is pumping blood. Basic facial features will begin to appear, including passageways that will make up the inner ear and arches that will contribute to the jaw. The foetal body begins to take on a C-shaped curvature. Small buds will soon become arms and legs. Tiny nostrils become visible, and the eye lenses begin to form. The arm buds now take on the shape of paddles. The arms and legs are growing longer, and fingers have begun to form.

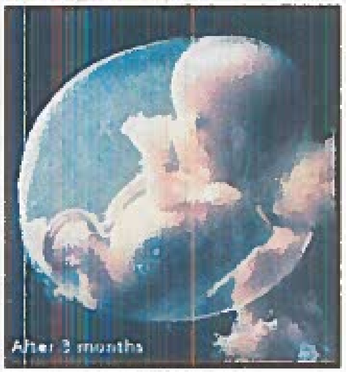

Fig: 21. 9

For Your Information

Ectopic pregnancy: A pregnancy in which the embryo implants in any site other than the uterus; most often the site is a uterine tube (tubal pregnancy). Since the uterine tube (as well as most other ectopic sites) is unable to establish a placenta or accommodate growth, the uterine tube ruptures unless the condition is diagnosed early, or the pregnancy spontaneously aborts.

The external parts of the baby's ears also are forming, and eyes are visible. The upper lip and nose have been formed. The trunk of body is beginning to straighten. To the end of first trimester the embryo can be now technically described as a foetus. Foetus is developing fingernails and face now has a human profile.

Fig: 21. 10

21.3.2 Foetal development: The second trimester

During the second trimester, the foetal sex becomes apparent and possibly identified during an ultrasound. In the second trimester uterus and ovaries are in place for a girl and the testes are beginning to descend for a boy. The foetal ears begin to stand out at the side of the head and the nerve endings from the brain connect to the ears allowing the foetus to hear. The head is about half of the overall size of the fetus. The foetus grows rapidly during the fifth month and internal organs continue to mature. Foetal muscle and body fat is being stored under the skin and body hair starts to appear. Fingers have developed fingerprints that are unique to every individual.

23.3.3 Foetal development: The third trimester

Final weight gain takes place, which is the most weight gain throughout the pregnancy. The foetus will be growing the most rapidly during this stage, gaining up to 28 g per day. The foetus begins to move regularly, and is felt by the woman. Movement of the foetus becomes stronger and more frequent and via improved brain, eye, and muscle function the foetus is prepared for ex utero viability. There is head engagement in the third trimester, that is, the foetal head descends into the pelvic cavity.

Forty weeks into pregnancy, or 38 weeks after conception, baby might be about 18 to 20 inches long and weighs 6 to 9 pounds, however, that healthy babies born in different sizes. It's just as normal to deliver a baby a week or two late — or early — as it is to deliver on due date.

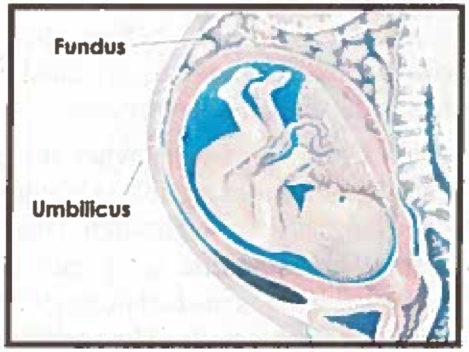

Fig: 21. 11

21.3.4 Twins and quadruplets

Apregnancy of two or more foetuses is called a multiple fetuses. Multiple fetuses can be the same (identical) or different (fraternal). Identical twins or triplets come from a single egg that has been fertilized by one sperm. For unknown reasons, the fertilized egg splits into two or more embryos during the first stage of development. Fraternal multiples come from multiple fertilized eggs.

Some identical multiples share the same placenta. However, they usually grow within separate amniotic sacs in the uterus. In rare cases, identical multiples share one amniotic sac. Fraternal foetuses have separate placentas and amniotic sacs.


Fig: 21. 12 Multiple pregnancy resulting in quadruplets.

23.3.5 Placentation:

Some cells of the embryo grow into a disk like structure called placenta. The placenta closely attached to the embryo by a tube called umbilical cord. The umbilical cord connects the embryo to the placenta. The blood vessels of the placenta are close to those of uterus so that oxygen, glucose, amino acids and salts can pass from the mother's blood to the embryo's blood. In a similar way carbon dioxide and urea in the embryo's blood escape in the placenta and are carried away by mother's blood in uterus.

The placenta can prevent some harmful substances in the mother's blood from reaching the embryo. It also produces hormones like estrogen and progesterone which helps in maintaining the pregnancy and prepare the mother for delivery. It also helps in the periodic contractions of uterus during delivery.

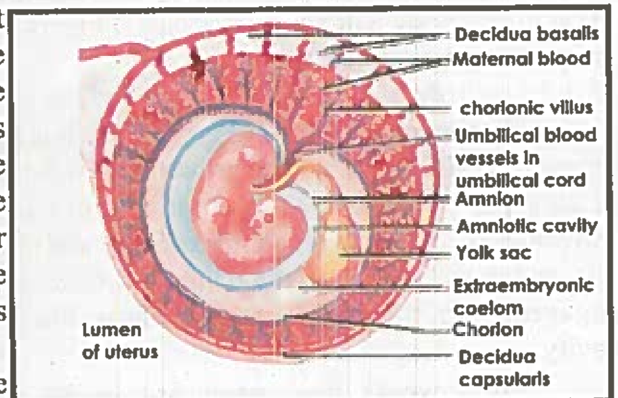

Fig: 21. 13 Placenta attached to the embryo by a tube called umbilical cord.

A few weeks before the birth, the head of the fetus is turned down in the uterus, just above the cervix. Childbirth begins when the muscular layers of uterus start to contract and relax. These actions are felt as labour pains. Opening of the cervix widens enough to let the baby head pass through. Head of the baby acts as a wedge to, assist cervical dilation. The amniotic sac breaks at some stage in labour and the fluid escapes. Finally the baby is pushed through the vagina (now called birth canal) into the outer world and birth occurs .The umbilical cord is cut and tied. After the birth of baby, contraction of uterus continues during which the placenta is expelled.The sudden fall in temperature felt by the newly born baby stimulate it to take its first breath and thus usually cries. In a few days, the remains of the umbilical cord attached to the baby's abdomen shrivel and fall away, leaving a scar in the abdominal wall, called the navel.

Lactation

The newborn baby is supplied with maternal milk soon after its birth. The mammary glands of the mother are especially prepared during the period of pregnancy under well-defined hormonal control. The secretory ducts within the mammary glands branch further and undergo enormous development and start producing milk by the end of the pregnancy.

The milk produced initially by the mammary glands contains special lymph like fluid known as colostrum which is quite rich in antibodies. Usually, the baby is fed on the maternal milk for upto two years. However, depending upon the general health condition of the mother as well as other physiological conditions, maternal milk may not be available for so long.

The baby is then fed on other sources of milk. As soon as the mother stops feeding the baby, her reproductive cycle begins again. However, sometimes the reproductive cycles can initiate even when the mother is breast feeding.

21.4.4 Breast Feeding Vs Bottle Feeding: There are advantages and disadvantages to both breastfeeding and bottle-feeding.

Advantages of Breast feeding:

- Breast milk has perfect balance of nutrient.
- It is easily digested and absorbed.
- Breast milk is always at perfect temperature.
- Milk is readily available at any time and any place.

Advantage of Bottle feeding

- The only advantage is anyone can feed the baby. Presence of mother is not necessary.

Disadvantages of Bottle feeding

- It can create unhygienic circumstances for the baby.
- It is vulnerable to carry various types of infections.
- It can cause indigestion and several stomach disorders.
- Not as efficiently utilized as breast milk.
- Some babies have difficulty in utilizing certain nutrients of the bottle milk.
- Bottle fed babies also have the risk of developing an allergy to a particular formula. When a baby develops an allergy to formula, he or she may have symptoms that include irritability, crying after feedings, nausea, vomiting, diarrhea, or a skin rash.

21.5 DISORDERS DURING EMBRYONIC DEVELOPMENT

21.5.1 Rubella: **Rubella**, commonly known as **German measles**, is a disease caused by the rubella virus. Rubella virus during pregnancy can be serious; if the mother is infectedwithin the first 20 weeks of pregnancy, the child may be born with congenital rubella syndrome (CRS). The syndrome (CRS) follows intrauterine infection by Rubella virus and comprises cardiac, cerebral, ophthalmic and auditory defects. It may also cause prematurity, low birth weight, anaemia and hepatitis

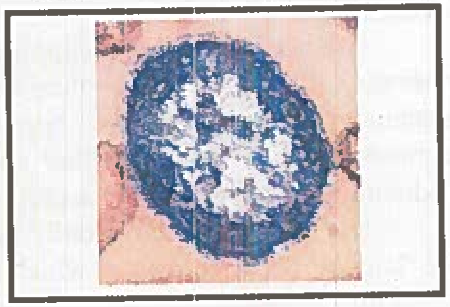

Fig: 21. 14 Rubella virus

21.5.2 Abnormal neural tube:

Neural tube defects (NTDs) are serious birth defects with symptoms that range from mild to severe impairment. They are caused by incomplete development of the brain, spinal cord and/or their protective coverings. This occurs when the foetus' spine fails to close properly during the early stages of pregnancy.

21.5.3 Thyroid gland:

In newborn infants with congenital hypothyroidism frequently have hyperbilirubinemia, and delayed skeletal maturation, reflecting immaturity of liver and bone, respectively, and they are at risk of permanent mental retardation if thyroid hormone therapy is delayed or inadequate; their size at birth, however, is normal.

21.5.4 Limb abnormalities:

The upper and lower limbs have a large number of different genetic and environment derived abnormalities, some of which can be surgically repaired. Among them partial or complete absence of limbs or digits are common.

21.5.5 Genetic abnormalities related to spontaneous abortions:

Approximately 50% of first trimester miscarriages are due to a chromosome abnormality in the fetus. An extra chromosome or a missing chromosome can cause miscarriage, usually in the first or second trimester of pregnancy, or can lead to a child with learning difficulties or mental retardation and birth defects. Chromosome abnormalities involving a missing or extra chromosome are not inherited or caused by an exposure during pregnancy. Instead, they result from a chance mistake in cell division soon after the time of conception. This error is a random event that can occur in anyone's pregnancy.

An inherited problem with the chromosomes can also cause miscarriage. A parent can have a rearrangement (a "translocation") of his or her chromosomes, in which the chromosomes are structured differently. Another genetic cause of miscarriage is a change in a single gene or several genes on the chromosomes. This can cause specific genetic diseases or birth defects.

Foetal surgery and detected foetal developmental problems

Recent developments and improvements in prenatal diagnostic methods, and in particular ultrasonography, have made detection of fetal abnormalities possible. Most defects are best treated after birth, only a few disorders are potentially treated surgically inside the mother body. Prerequisites for foetal surgery include the selection of those fetuses who might benefit from intrauterine treatment, counselling of the family concerned, and a highly experienced multidisciplinary team including a perinatal obstetrician, an ultrasonographer, a pediatric surgeon and a neonatologist. In human beings intrauterine treatment has been performed in erythroblastosis foetalis, urinary tract obstruction with encouraging results.

21.6 POSTNATAL DEVELOPMENT

21.6.1 Allometric growth:

The term means differential growth and refers to developmental patterns of growth which are not uniform, that is, not all parts of the organism develop at the same rate. An example of allometry is leg length in humans. The foetal and newborn baby has short, chubby, and ineffectual legs. The proportion of leg length to body length is low. About half of the adult height is accounted for by leg length. Obviously, legs acquire length disproportionately compared with body length.

21.7 AGING

Usually aging refers to the physiologic changes that occur in all individuals due to age. The sequence of the changes is consistent among all people, the rate, however, can differ greatly. Both genetics and environment impact age-related changes. Siblings with the same genetic background can have marked differences in longevity due to environmental factors or secondary aging. The causes of secondary aging may be preventable.

21.7.1 Process of Aging:

Aging is a progressive physiological process that is characterised by degeneration of organ systems and tissues with consequent loss of functional reserve of these systems. Loss of these functional reserves impairs an individual's ability to cope with physiological challenges such as anaesthesia and surgery.

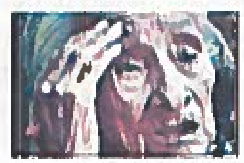

Fig: 21. 15 Aging is a natural process.

Individuals of the same chronological age may differ significantly in the rate and severity of functional decline. Persons who maintain greater than average functional capacity are considered 'physiologically young' and those whose function declines at an earlier age appear to be 'physiologically old'.

21.7.2 Signs and symptoms:

There are many different signs and symptoms of aging. Most of these develop gradually and are very diverse, but it should be remembered that it is not possible to diagnose aging based on isolated signs and symptoms alone. Different people possess widely varying degrees of these signs and symptoms. Some of these include:

- An overall decrease in energy and vigour
- Changes in sleeping patterns
- Decreased memory
- Skin and hair changes such as wrinkles, brown spots on the skin, loss of skin elasticity, and hair loss
- A loss or decrease in vision and hearing
- Sexual dysfunction
- Urinary problems such as incontinence, dribbling, and changes in frequency of urination
- Changes in menstrual cycle
- Abdominal obesity and inability to lose weight

Secondary aging processes result from disease and poor health practices (e.g. no exercise, smoking, excess fat and other forms of self-damage) and are often preventable, whether through lifestyle choice or modern medicine.

Stop smoking it even leads to early aging process.

21.7.3 Cell level changes in aging:

All cells change as they age. Cells become larger. Their capacity to divide and reproduce tends to decrease. Normal cells have built-in mechanisms to repair minor damage, but the ability to repair declines in aging cells.

DNA is damaged through the aging process and changes occur:

- in cellular membranes;
- in enzymes;
- in the transport of ions and nutrients;
- in the nucleus chromosomes undergo such changes as clumping, shrinkage, and fragmentation.

Other changes occur in such organelles as the mitochondria and lysosomes where numbers are reduced, causing cells to function less efficiently. This effect also ties in with a decrease in hormonal secretions.

A decrease in metabolism has several effects:

- toleration of cold is less;
- a tendency to gain weight increases;
- there is a decreased efficiency in the body's use of glucose.
- Collagen and elastin decrease in connective tissue formation
- Lipid and fat content of tissues change.
- The total amount of water in the body gradually decreases

21.7.4 System level changes in aging:

The GI tract in general maintains its functional level well into old age. There are three areas that are the exceptions: altered taste decreased stomach acid and decreased blood flow to the liver. In the mouth, there is a decrease in saliva which affects chewing and swallowing. Also, altered taste makes food less palatable.

Osteopenia and osteoporosis both deal with bone loss; the difference is the degree of loss. Between the ages of 30 and 40, men and women start to lose bone mass and enter a condition called osteopenia, a decreased or lower mineral content of the bone. Osteoporosis then is a greater degree of osteopenia and involves both a decrease in bone minerals and a decrease in bone matrix.

Usual aging is accompanied by a lower production of neurotransmitters, but only when the drop approaches 50% will dementia ensure. About 15% of the elderly have severe dementia.

The heart of an elderly person could be smaller than normal due to malnutrition, larger than normal due to severe high blood pressure, or unchanged in size. Usual aging causes the left ventricular wall to thicken and the diameter and length of the aorta, a major artery leaving the heart, to increase. Fat will accumulate in the heart muscle as a response an increase in total body fat.

Infections occur more frequently in the elderly and are more often severe due to low degree working of immune system.

KEY POINTS

- An organism changes from a fertilized egg into an adult. The progressive changes which are undergone before an organism acquires its adult like form constitute the embryonic development.
- Early divisions of the zygote are called **cleavages**.
- The extraembryonic membranes that form during the first two to three weeks of development include the amnion; yolk sac, allantois, and chorion.
- During week 3, the two-layered embryonic disc transforms into a three-layered embryo in which the primary germ layers—ectoderm, mesoderm, and endoderm present. This process, called gastrulation, involves cellular rearrangements and migrations.
- The formation of organs and systems during embryonic development is called organogenesis.
- The first major event in organogenesis is neurulation, the differentiation of ectoderm that produces the brain and spinal cord.
- Every gene is present in every cell of developing embryo.
- The nucleus determines the characteristics of the individual, while the cytoplasm selectively "turns on" some genes and "switches off" others.
- A normal pregnancy lasts nine months.
- Each three-month period of pregnancy is called a trimester. During each trimester, the foetus grows and develops.
- Implantation takes place in the fourth week of pregnancy.
- A pregnancy of two or more foetuses is called a multiple pregnancy.
- Multiple fetuses can be the same (identical) or different (fraternal). Identical twins or triplets come from a single egg that has been fertilized by one sperm.
- The placenta is closely attached to the embryo by a tube called umbilical cord. The umbilical cord connects the embryo to the placenta.
- Rubella virus during pregnancy can be serious; if the mother is infected within the first 20 weeks of pregnancy.
- Allometric growth means differential growth and it refers to developmental patterns of growth which are not uniform. An example of allometry is leg length in humans.
- Aging is a progressive physiological process that is characterised by degeneration of organ systems and tissues with consequent loss of functional reserve of these systems.

EXERCISE ?

1. Multiple Choice questions

i. *The protective coat which surrounds the embryo is known as:*
(a) amnion (b) chorion
(c) allantosis (d) chorio allantoic

ii. *The outer layer of the blastocyst, which later attaches to the uterus, is the*
(a) Deciduas (b) Trophoblast
(c) Amnion (d) inner cell mass

iii. *Identical twins result from the fertilization of;*
(a) one ovum by one sperm (b) one ovum by two sperms
(c) two ova by two sperms (d) two ova by one sperm

iv. *The most important hormone in initiating and maintaining lactation after birth is;*
(a) estrogen (b) FSH
(c) Prolactin (d) Oxytocin

2. Short questions

i. The life span of the ovarian corpus luteum is extended for nearly three months after implantation, but otherwise it deteriorates.
(a) Why this is so.
(b) Why it is important that the corpus luteum remain functional following implantation.

ii. What factors are believed to bring about uterine contractions at the termination of pregnancy?

iii. The placenta is a marvelous, but temporary, organ. How it is an intimate part of both fetal and maternal anatomy and physiology during the gestation period?

iv. What is importance of cleavage?

3. Long Questions

i. Describe the process of early cleavage and blastocyst formation.

ii. Explain the role of nucleus in the control of development by demonstrating the work of Hammerling.

iii. Give a brief over view of the work done by Hans Spemann in the discovery of embryonic induction.

EXERCISE

iv. Discuss the major events of human embryonic development during first trimester.

v. Elaborate the role of feotal and maternal hormones initiating labour pain and culminating in the birth of baby.

4. **Analyzing and Interpreting**
- Identify the group of vertebrates through diagrams of different blastula.
- Identify the different stages in chick development through observation of prepared slides.
- Using the knowledge of about the postnatal growth of brain and jaws; interpret why a six month old baby have the same jaw skull proportions as it had at the time of birth.

5. **Initiating and Planning**
- Explain why proper nourishment of the mother is imperative during the third trimester of pregnancy.
- Why oxytocin is involved in the secretion of milk, hypothesize why new mothers often experience cramps in uterus while nursing.

6. **Communication**
- Draw a table to list the events of human development in the first, second and third trimester.

7. **Science, Technology, and Society Connections**
- Draw how a blastula is divided into two (by using micromanipulator) to produce twins of animals for biological research.
- Rationalize that nursing is an important bonding time between mother and child, as it provides the child with protection by mother's immune system while its own develops.
- List some of the diseases due to aging and what medical science is doing to treat these diseases.

8. **Online Learning**
- www.nchd.org.pk
- www.hdf.com
- www.embryocd.ch
- www.embryo.chronolab.com
- www.med.uc.edu/embryology