DEVELOPMENT AND AGING

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

EXERCISE

SECTION I: Multiple Choice Questions

Select the correct answer from the following choices.

1. How does a zygote differ from an ovum?
   (a) a zygote has more chromosomes
   (b) a zygote is smaller
   (c) a zygote is much larger
   (d) a zygote divides by meiosis

2. A woman has several miscarriages. Her doctor suspected that a hormonal insufficiency was causing the lining of the uterus to breakdown, as does during menstruation, terminating her pregnancies. Treatment with which of the following might help her pregnancy?
   (a) oxytocin
   (b) luteinizing hormone
   (c) follicle stimulating hormone
   (d) progesterone

3. In human development, ectoderm cells migrate through the primitive streak to form:
4. The process by which a tissue causes another tissue to differentiate is called:
   (a) gastrulation (b) metamorphosis (c) cleavage (d) induction

5. Which of the following has three germ layers?
   (a) embryonic disc (b) blastula (c) gastrula (d) trophoblast

6. Which of the following consists of both foetal and maternal tissue?
   (a) umbilical cord (b) placenta (c) amnion (d) allantois

7. 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

8. Which of the following are mismatched?
   (a) endoderm; lining of the digestive tube
   (b) ectoderm; circulatory system
   (c) mesoderm; notochord
   (d) mesoderm; reproductive system

Answer:

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**SECTION II: Short Questions**

Give short answers of the following questions.

Q1. What is the difference between primary and secondary induction?
   **Answer**
   The tissue which first influence inducing the development of a secondary embryo in the host. Spemann termed this inductive event as primary induction, because he believed it to be the first inductive event in development.

   Secondary induction: When many other cell types originate by inductive interactions, a process called secondary induction.

Q2. What is the basis of pregnancy test?
   **Answer**
   Pregnancy test, which is based on the fact that HCG is present in the blood and urine of a pregnant woman.

Q3. Name the four extra-embryonic membranes and give a function of each.
   **Answer**
   Establishment of extra embryonic membrane is one of the major events in early development. The term extra embryonic membrane is appropriate because these membranes extend out of the embryo. These are amnion, yolk sac, allantois and
chorion.

1) **Amnion:** It provides a fluid environment for the developing embryo and foetus. Firstly, amnion is seen above the embryo later on it surrounds the embryo.

2) **Yolk sac:** The yolk sac appears below the embryo. In humans, the yolk sac contains no yolk and is the first site of red blood cell formation. Part of this membrane becomes incorporated into the umbilical cord.

   iii) **Allantois:** The allantois contributes to the circulatory system. Its blood vessels become blood vessels of umbilical cord, which transport foetal blood to and from the placenta.

   iv) **Chorion:** The outer extra embryonic membrane surrounds the embryo. It becomes the part of the placenta.

**Q4.** At what point in parental development of a human does the zygote exhibit a new genetic makeup different from that of either parent?

**Answer**

When there is a meiosis, a specific type of cell division, genes are exchanged between homologous chromosomes and as a result sex cells would be having new gene combinations. When such sex cells (egg and sperm) would fuse with new gene combination, a zygote would be having different genetic makeup than its parents.

**Q5.** What happens to sperm and secondary oocyte immediately after fertilization occurs?

**Answer**

After fertilization the first diploid cell of a young one is produced called zygote (2n). Zygote undergoes some changes which leads to the formation of foetus and then ultimately to an adult.

**Q6.** What is the function of amniotic fluid?

**Answer**

1) Amniotic fluid absorbs the shocks and trauma. Aniotic fluid is also important for several reasons.

2) It helps to keep baby warm.

3) Amniotic fluid provides lubrication.

**Q7.** What are two very different functions of placenta?

**Answer**

i) Placenta is an organ that connects the developing foetus (foetus) to the uterine wall to allow nutrient up take, waste elimination, and gas exchange via the mother blood supply.

ii) Placenta is an endocrine organ that secretes hormones, progesterone and estrogen to maintain the pregnancy.

**Q8.** Give the functions of chorion, amnion, allantois and yolk sac.

**Answer**

Establishment of extraembryonic membrane is one of the major events in early development. The term extra embryonic is appropriate because these membranes
extend out of the embryo. These are: amnion, yolk sac, allantois and chorion.

i) The amnion provides a fluid environment for the developing embryo and foetus. Firstly amnion is seen above the embryo; later on it surrounds the embryo.

ii) The yolk sac appears below the embryo. In humans, the yolk sac contains no yolk and is the first site of red blood cell formation. Part of this membrane becomes incorporated into the umbilical cord.

iii) The allantois contributes to the circulatory system. Its blood vessels become blood vessels of umbilical cord, which transport foetal blood to and from the placenta.

iv) Chorion, the outer extraembryonic membebrane surrounds the embryo. It becomes the part of the placenta.

Q9. List the tissues and organs formed from the three germinal layers.
Answer
i) Ectoderm: Ectoderm gives rise to nervous system and skin epidermis.

ii) Endoderm: It forms the epithelial linings of digestive, respiratory and ungenenial system and associated organs.

iii) Mesoderm: Forms virtually everything else.

Q10. How umbilical cord is detached from baby?
Answer
After the delivery of baby (second stage of birth) the umbilical cord is still attached to the baby. The umbilical cord is clamped artificially as early as 1 to 5 minutes after birth of the child. Clamping is followed by cutting of cord, which is painless due to lack of any nerve.

Q11. What is the role of prolactin in the production of milk and of oxytocin in the secretion of milk?
Answer
Rising levels of (placental) estrogen, progesterone and lactogen towards the end of pregnancy stimulate the hypothalamus to release prolactin-releasing hormone (PRH). This in turn stimulates the anterior pituitary gland which responds by secreting prolactin. Prolactin prepares the mammary gland for milk production. True milk production begins after a delay of two to three days of birth.

Q12. How regulation at the end of milk production takes place?
Answer
After birth, prolactin release gradually wanes (decrease) and continual milk production depends on mechanical stimulation of nipples normally provided by sucking infant. Mechano receptors in nipple send message in the form of impulses to hypothalamus stimulating secretion of PRH. This cause burst like release of prolactin, which stimulates milk production for the next feeding.

The sucking of the baby on the breast stimulates sensory receptors around and in the nipple. Nerve impulses pass from the receptors to the hypothalamus which also stimulate posterior pituitary to release oxytocin via a positive feedback mechanism. Oxytocin causes dilation of milk ducts and thus promotes ejection of milk from the
alveoli of the mammary glands. During nursing oxytocin also stimulates the recently emptied uterus to contract, helping it to return to its pre-pregnant size.

As long as milk is removed from breasts, prolactin and oxytocin continue to be released. When nursing is discontinued, the stimulus for prolactin release and milk production ends, and within about one week, the mammary glands lose their capacity to produce milk.

Q13. When oxytocin is involved in the secretion of milk, hypothesize why new mother often experience cramps in uterus?

**Answer**
The stimulus of sucking releases oxytocin oxytocin also stimulates contraction of muscles in the uterus, helping it to recover its normal tone after birth, thus new mother often experience cramps in the uterus while nursing.

Q14. Rationalize aging as a part of normal development.

**Answer**
Aging can be defined as the progressive changes over time, leading to loss of physiological function and eventually death. Aging is negative physiological changes in our body.

The study of aging is called gerontology. Development does not cease once birth has occurred, but continues throughout the stages of life. The human life span is judged to be maximum of 110-115 years. After growth and differentiation cells begin to deteriorate. There is gradually a loss of efficiency in cellular function.

Q15. List the genetic and extrinsic factors responsible for aging in humans.

**Answer**

**Factors Responsible for Aging**

There are many theories about what causes aging. Two of these, the genetic and extrinsic factors are considered here.

**Genetic factor**

Several evidences have been discovered that show aging has a genetic basis. Experiments have shown that human cells will divide less than 100 times outside the body. This is because of short length of telomeres, the specific nucleotide sequences at the end of chromosomes. When we are conceived our telomeres are full length but each time a cell divides, the length of telomeres is decreased (like the way lead in a pencil wears down when you write with it.) If these sequences are shortened to a critical length, the cell is no longer able to divide. When cells cannot divide, damaged tissues cannot regenerate and we begin to wear out.

**Extrinsic factor**

Aging is due to years of poor health habits. Osteoporosis is the progressive decline in bone density as a result fracture is most likely to occur. While there is no denying that osteoporosis occurs as result of aging, certain extrinsic factors are also important. The occurrence of osteoporosis itself is associated with cigarette smoking, heavy alcohol intake and perhaps inadequate calcium intake. A moderate exercise program has been found to slow down the progressive loss of bone mass. If the diet includes fruits and
vegetables, good health habits sensible exercise will most likely help to eliminate cardiovascular disease, the leading cause of death today.

Q16. What are the changes recognized as primary and secondary aging?

Answer

Signs and Symptoms of Aging
There are different signs and symptoms of aging. Most of these develop gradually and different people possess varying degrees of these signs and symptoms which can be divided into two groups i.e., primary aging and secondary aging.

Primary Aging
As aging occurs there are fewer hair follicles, so the hair on the scalp and extremities thins out. Older people experience a decrease in the number of melanocytes, making hair grey and skin pale. In contrast, some of the remaining pigment cells are larger and pigmented blotches appear in skin. The immune system, too no longer performs as it once did and this causes decreased resistance to infection. The other effects of aging are: deafness (in particular lack of ability to hear high notes), fading vision, and reduced ability to adapt to stress. It is important to remember that different individuals can be affected to different extent.

Secondary aging
The characteristics that are the result of environmental, life style factors such as diseases, disuse and abuse are considered as secondary aging. The disuse is lack of exercise and abuse includes smoking, obesity, malnutrition and exposure to ultra-violet light.

Q17. List some changes that occur at cellular level during aging.

Answer
All cells change as they age.

i) Cells become larger. Their capacity to divide and reproduce tends to decrease.

ii) Normal cells have built in mechanism to repair minor damage, but the ability to repair declines in aging cells.

iii) DNA is damaged through the aging process and changes occur in cellular membranes, in enzyme, in the transport of ions and nutrients, in the nucleus of chromosomes where such changes are clumping, shrinkage and fragmentation occur.

iv) Other changes occur in such organelles as the mitochondria and lysosomes where numbers are reduced, causing cells to function less efficiently.

Q18. Why nourishment of mother is imperative during the third trimester of pregnancy?

Answer
The third trimester is a period of growth. The mothers blood stream fuels all of this growth by the nutrients it provided. Within the placenta these nutrients pass into foetal blood supply. If the foetus is malnourished because the mother is malnourished, this growth can be relatively affected. The result is the severely retarded infants, so proper nourishment of mother is necessary.
fourth germ layer.

x) Primary Organizer
Any tissue capable of inducing the development of a secondary embryo in the host. Spemann designated the development of secondary embryo in the host.

xi) Amnion
The amnion is one of the extraembryonic membrane, which provides fluid environment for developing embryo and foetus. Firstly amnion is seen above the embryo, later on it surrounds the embryo.

xii) Allantois
It is a second extra-embryonic membrane, which contributes to the circulatory system. Its blood vessels become blood vessels of umbilical lord, which transport foetal blood to and from the placenta.

xiii) Chorion
The outer most extra embryonic membrane surrounds the embryo. It becomes the part of the placenta.

xiv) Primary Induction
When any tissue inducts first event in development. This inductive event is called primary induction.

xv) Secondary Induction
Subsequent studies showed that many other cell types originate by inductive interactions, a process called secondary induction. For example, cells of the neural plate induce neural crest in the embryo.

xvi) Primary Organizer
Area / tissue which is capable of inducing the development of a secondary embryo in the host Spemann designated the dorsal lip area the primary organizer.

xvii) Chorionic Gonadotropin (HCG)
After fertilization the zygote undergoes several mitotic divisions called cleavage. If the implantation is successful the embryo begins to secrete human chorionic gonadotropin (HCG). This hormone forces the corpus luteum, the ovary to continue to secrete progesterone, thereby maintaining the endometrium and inhibiting FSH production.

xviii) Gestation Period
After conception (pregnancy) till the delivery time, the whole time period during the development and growth in mother body is called gestation period. That is about 280 days or 9 months.

xix) Umbilical Cord
As the human embryo grows, the umbilical cord (also called naval string) develops and connects the embryo to the placenta. The umbilical cord is physiologically and genetically part of fetus and (in humans) normally contains two arteries (The umbilical arteries) and one vein (the umbilical vein). The umbilical vein supplies the foetus with
oxygenated nutrient rich blood from the placenta. Conversely, the foetal heart pumps deoxygenated, nutrient depleted blood through umbilical arteries back to placenta.

xx) Placenta
Placenta is an organ that provide nutrients and oxygen to the embryo and helps to dispose of its metabolic wastes, formed of embryos chorion, and mothers endometrial blood vessels.

xxi) Identical Twins
Identical twins or triplets or quadruplets come from a single egg that has been fertilized by one sperm therefore also called monozygotic. For unknown reasons, the zygote splits into two or more embryos during the first stage of development. 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. Identical multiples are always of the same sex and blood type. They do not always look exactly alike. One may be right-handed while the other is left-handed and have different hand fingerprint due to exposure of different environment in later life.

![Diagram of Identical Twins versus Fraternal Twins](image)

**Fig. Identical Twins versus Fraternal Twins**

xxii) Fraternal Twins
Fraternal twins or triplets or quadruplets come from multiple eggs fertilized by different sperms therefore also called dizygotic or multiple zygotic. Fraternal foetuses have separate placentas and amniotic sacs. They can be of different sexes and have different blood types and may look very different from one another, with different coloured hair and eyes. They may also look alike, as siblings often do.

xxiii) Parturition
Parturition means birth of baby. Towards the end of pregnancy the uterus becomes progressively more excitable, till finally it develops such strong rhythmical contractions that the baby is expelled. There are several factors involved in onset of this excitation like increased ratio of estrogen to progesterone, foetal hormones and maternal hormones.

xxiv) Pre-term Birth
Pre-mature birth is also called pre term birth. It refers to the birth of a baby of less than 37 weeks of gestational age.
Factors: These are the factors caused by smoking, not getting good parental care, having health conditions such as high blood pressure, diabetes, blood clotting disorders or infections, being pregnant with a baby that has certain birth defects, being pregnant with a baby from in vitro fertilization and getting pregnant too soon after having baby.

xxv) Lactation / Nursing
Lactation or nursing is secretion and yielding of milk by mother after giving birth. The milk is produced in mammary glands, which are contained within the breasts. The first secretion of the breasts, following birth, not milk but colostrum this has a yellow colour. It is rich in the protein globulin. It contains little fat and less lactose than the milk.

xxvi) Prolactin Hormone
Rising level of (placental) estrogen, progesterone and lactogen towards the end of pregnancy stimulate the hypothalamus to release prolactin releasing hormone (PRH). This in turn stimulates the anterior pituitary gland which responds by secreting prolactin. Prolactin prepares the mammary glands for milk production.

xxvii) 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 infected within the first 20 weeks of pregnancy, the child may be born with congenital rubella syndrome (CRS). Rubella virus can cause malformations of the eye 6th week of pregnancy (cataract), Internal ear (congenital defects due to destruction of organ of cornii), heart 5th to 10th week of pregnancy (persistence of ductus arteriosus as well as ventricular septal defects) and occasionally teeth 6th – to 9th week of pregnancy (enamellayer).

xxviii) Spina Bifida
Most of defects of spinal cord result from abnormal closure of neural folds in the 3rd and 4th week of development. The resulting abnormalities are known as neural tube defects.
Spina bifida refers to a splitting of vertebral arches. So this spinal bifida is a defect in the vertebral arches that is covered by skin.
It occurs in the lumbosacral region. The defects are due to lack of fusion of the vertebral arches.

xxviii) Gerontology
The study of aging is called gerontology.
Q1. Describe cleavage and relate it with the amount of yolk.

**Answer**

**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 which leads to a multicellular stage called embryo, finally an adult like body is formed. The study of an organism at this stage is called embryology. The process of embryonic development comprises following stages: cleavage, gastrulation, organogenesis and growth.

**Cleavage**

Following fertilization, the zygote undergoes a mitotic division called cleavage.

**Morula and Blastula**

The first division results in the formation of two identical cells called blastomere. DNA replication and mitotic division occur repeatedly. The cells get smaller and smaller with each division. Finally a solid ball of small cells, the morula is formed. The morula is still about the same size as the zygote. As cleavage or division continues, cells begin to move apart, so that spaces appear among cells in the centre of mass. Cells keep moving away from the central area, forming a fluid cavity known as blastocoel. This hollow-sphere embryo which develops at the end of cleavage is called blastula. This embryonic stage in mammals is called blastocyst. 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.

![Fig. Cleavage in human zygote](image)

**Different patterns of cleavage based upon amount of yolk**

Many animal eggs contain yolk. The yolk is a mixture of proteins, phospholipids and fats and serves as food for developing embryo. The amount and distribution of yolk vary among different animal groups. Most invertebrates and simple chordates have eggs with relatively small amounts of yolk uniformly distributed through the cytoplasm. Many vertebrates have large amounts of yolk concentrated at one end of the cell known as the vegetal pole. The opposite pole is called the animal pole. The amount of the yolk in the egg affects the pattern of cleavage. The cleavage is of two types: holoblastic cleavage, meroblastic cleavage.
Holoblastic Cleavage

In eggs with evenly distributed yolk, the entire egg divides, producing cells of roughly the same size. This type of cleavage is termed holoblastic, e.g., bony fishes and amphibians.

Meroblastic Cleavage

The eggs of reptiles, birds and some fishes have a very large amount of yolk and only a small amount of cytoplasm concentrated at the animal pole. In such eggs, cell divisions take place only in the blastodisc, the small disc of cytoplasm at the animal pole. This type of cleavage is termed meroblastic.

Q2. Explain the events of gastrulation.

Answer

Gastrulation

Gastrulation is the second major phase of embryonic development which is characterized by differentiation of embryonic germ layers. In the process, the embryo is transformed from a hollow ball of cells, the blastula, into a three layered stage called the gastrula. The three layers produced in gastrulation are embryonic tissues called ectoderm, endoderm and mesoderm. The mechanism of gastrulation varies somewhat depending on the species.

Gastrulation in Humans

In human embryo, gastrulation begins about the 15th day after fertilization. During this phase, the trophoblast thickens at one point to form a mass of cells called inner mass cells. After implantation, the inner cell mass grows and splits, forming two fluid-filled sacs that are separated by a double layer of cells called the embryonic disc. One sac is amniotic sac which is bounded by the amnion and filled by amniotic fluid. The other sac is yolk sac but it does not contain yolk as human embryo takes nutrition from the mothers body. At this stage, the embryonic disc consists of an upper layer and a lower layer. The upper is called epiblast (on the side facing the amniotic sac) which later on develops into ectoderm and mesoderm. The lower layer is called hypoblast (on the side facing away from the amniotic sac) which later on develops into endoderm.
facing the yolk sac) which is future endoderm. The upper and lower layers split apart slightly and a slit, the primitive streak (corresponding to the blastopore) appears in the centre of the upper layer. The upper layer is now called ectoderm and inner layer is called endoderm. The cells of the ectoderm migrate through the primitive streak into the interior of the embryo forming the mesoderm.

![Diagram](image_url)

Fig. (a) Human gastrulation: The amniotic cavity forms within the inner cell mass, (b-c) and in its base, layers of ectoderm and endoderm differentiate. (d) A primitive streak develops, through which cells destined to become mesoderm migrate into the interior.

**Fate of three embryonic germ 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 urinogenital systems and associated glands. Mesoderm forms virtually everything else. The formation of organs and system 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.

**Neurulation in human Embryo**
Q3. Define neurulation. State events of neurulation and explain its significance.

Answer

In human embryo, the process of neurulation begins during the first month of development. The nervous system develops from the middle ectoderm located just above the notochord. The developing notochord induces (stimulates) the overlying ectoderm to thicken, forming the neural plate which is seen along the dorsal surface of the embryo. Central cells of the neural plate move downward and form a depression called the neural groove. Then neural folds develop on either side of a neural groove. By 22nd day, the continued cell movement brings the superior margins of the neural folds closer together until they meet and fuse forming the neural tube. It soon pinches off and becomes covered by surface ectoderm. At this point the embryo is called neurula. Later the anterior of the neural tube grows and differentiates into brain; the remainder of the tube develops into the spinal cord.

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 stem and brain waves can be recorded.
Q4. Describe the formation of neural crest and list the structures that are derived from neural crest cells.

Answer

**Formation of Neural Crest and Its Role In Development**

Various motor nerves grow out of the developing brain and spinal cord, but sensory nerves have a separate origin, the neural crest which is developed in the region of the neural plate border. After neural tube closure, the associated neural crest cells migrate widely to the lateral sides of neural tube and give rise to the cranial, spinal, and sympathetic ganglia and associated nerves. Neural crest cells subsequently migrate to various parts of the embryo, forming peripheral nerves, medulla of the adrenal gland, teeth, skull bones and so many other different cell types that some have proposed considering neural crest cells as a fourth germ layer.

Growth is the most obvious phase of development which is characterized by increase in size and mass of an organism. It begins soon after fertilization and continue throughout the development. In human embryo the process of organogenesis is almost accomplished in the embryo of about eight weeks. By the start of third month the human embryo is called foetus. The rest of the development period comprises only growth and maturation of organs and systems.

Q5. Describe the experiments of Spemann on the development of neural tube to explain the embryonic induction.

Answer

**Hans Spemann’s Experiment**

Hans Spemann introduced a new approach to testing the Roux-Weismann hypothesis. Spemann placed minute ligatures of human hair around salamander zygotes just as they were about to divide, constricting them until they were almost, but not quite, separated into two halves. The nucleus lay in one half of the partially divided zygote; the other side was anucleate, containing only cytoplasm. The zygote then completed its first cleavage division on the side containing the nucleus; the anucleate side remained undivided. Eventually, when the nucleated side had divided into about 16 cells, one of the cleavage nuclei would wander across the narrow cytoplasmic bridge to the anucleate side. Immediately, this side began to divide. With both halves of the embryo containing nuclei, Spemann drew the ligature tight, separating the two halves of the embryo. He then watched their development. Usually two complete embryos will be resulted. This showed that a single nucleus selected from the...
16-cell embryo contained a complete set of genes; all were equivalent.

Sometimes, however, Spemann observed that the nucleated half of the embryo developed only into an abnormal ball of belly tissue, although the half that received the delayed nucleus developed normally. Here question arises, why nuclei of 15 cells out of 16 fail to develop and the one which was transferred to non-nucleated side resulted in embryo development? **Explanation:** Spemann discovered, depending on the position of the grey crescent, the pigment-free area that appears at the moment of fertilization. If one-half of the constricted embryos lacked a part of the grey crescent, it would not develop instead will change into undifferentiated mass of cells.

**Conclusion**

Spemann's delayed nucleation experiments served as compelling evidence for two important conclusions:

1) All cells contain the same nuclear information (thus disproving the Roux-Weismann hypothesis),

2) Cytoplasm in the area of the grey crescent must contain information essential for normal development.

If all nuclei are equivalent, what causes some cells to develop into neurons while others develop into skeletal muscle? In most animals (excluding insects), there are two major ways by which cells become committed to particular developmental fates:

1) Cytoplasmic segregation of determinative molecules during cleavage.

2) Interaction with neighbouring cells (inductive interactions)

All animals use both of these mechanisms to some extent to specify different cell types. However, in some animals cytoplasmic specification is dominant, whereas others rely predominantly on inductive interactions. From all these experiments, it was concluded that both nucleus and cytoplasm play an important role in the development. Nucleus contains all the genes, which determine the characteristics of the individual while cytoplasm is involved in the selection of genes in particular cell type as it contains some components called morphogenetic determinants (determinative molecules) that are involved in the expression of genes.

**Embryonic Induction**

The capacity of some cells to evoke a specific developmental response in others is called embryonic induction. It is a widespread phenomenon in development which was reported by Hans Spemann and Hilde Mangold in 1924 in a series of classic experiments on amphibians embryos.

**First Experiment**

In an experiment, they took an amphibian (newt) embryo at gastrula stage and cut out the piece of ectoderm from dorsal lip of the blastopore, which normally becomes the neural tube and put the piece of ectoderm in a separate dish. An embryo from which the piece was taken healed and lived, but it had either a defective nervous system or none at all. Moreover, the isolated piece of ectoderm did not form a nervous system, though it remained alive and healthy. Based upon these observations, they concluded that due to the removal of the piece of ectoderm, the particular morphogenetic
determinants have been lost which come into this region during cytoplasmic segregation. Therefore, the particular ectoderm should remain attached to the embryo for the proper development of nervous system.

Fig. Spemann's experiment showing the demonstration of embryonic induction (a) The blastopore lip from an early gastrula of a pigmented newt embryo was transplanted to the ventral vegetal side of an unpigmented recipient embryo. Because of the differences in pigmentation, the donor and recipient tissues could be distinguished visually. (b) The donor tissue induced the recipient tissue to form a secondary embryonic axis containing a notochord, neural tube, somites, and gut. (c) Eventually, a twinned embryo developed.

Second Experiment
In another experiment, they cut a flap of ectoderm from the dorsal lip of the blastopore. Unlike previous experiment, they did not remove it, but just folded it back. Then they cut out the mesoderm underneath and discarded. Finally, they folded the flap of ectoderm back in its place. The ectoderm healed and looked quite healthy, but it did not develop into a nervous system. They concluded that beside cytoplasmic segregation the interaction neighbouring cells is also required for proper differentiation and development. Therefore, when the piece of mesoderm was removed, the ectoderm did not differentiate into neural tissue. The mesoderm must influence the ectoderm somehow to differentiate into nerve tissue. In order to confirm this hypothesis, they performed another experiment.

Third Experiment
In this experiment, when a piece of dorsal blastopore lip from a salamander gastrula was transplanted into a ventral or lateral position of another salamander gastrula, it invaginated and developed a notochord and somites. It also induced the host ectoderm to form a neural tube. Eventually, a whole system of organs developed where the graft was placed, and then grew into a nearly complete secondary embryo. This creature was composed partly of grafted tissue and partly of induced host tissue. It was soon found that only grafts from the dorsal lip of the blastopore were capable of inducing the
formation of a complete or nearly complete secondary embryo. This area corresponds to the presumptive areas of notochord, somites, and prechordal plate. It was also found that only ectoderm of the host would develop a nervous system in the graft and that the reactive ability was greatest at the early gastrula stage and declined as the recipient embryo got older.

Spemann designated the dorsal lip area the primary organizer because it was the only tissue capable of inducing the development of a secondary embryo in the host. He also termed this inductive event primary induction because he believed it to be the first inductive event in development. Subsequent studies showed that many other cell types originate by inductive interactions, a process called secondary induction. For example, cells of the neural plate induce neural crest in the embryo.

Q6. Describe the development in Humans in terms of First, Second and Third Trimester.

Answer

Human pregnancy can be divided roughly into three trimesters, each approximately three months long. The first trimester is from the last menstrual period (LMP) to the 13th week, the second trimester is from the 14th to 27th week, and the third trimester is from the 28th week to 42nd weeks.

First Trimester

Since the gestation period starts from last menstrual period (LMP), therefore, fertilization, blastocyst formation and implantation of blastocyst are included in 1st trimester. In addition, 1st trimester also comprises development of placenta, extra embryonic layers and major events of organogenesis.

Fertilization, blastocyst formation and implantation

After fertilization, the zygote undergoes cleavage that leads to the formation of blastocyst. By the end of the 2nd week, implantation of the blastocyst in the endometrium begins. The endometrium responds to implantation by growing over the blastocyst. During the first 2-4 weeks of development, the embryo obtains nutrients directly from the endometrium. Meanwhile the trophoblast (outer layer of the blastocyst), grows out and mingle with the endometrium, eventually helping to form placenta.

Extraembryonic membrane

Establishment of extraembryonic membranes is one of the major events in early development. The term extraembryonic membrane is appropriate because these membranes extend out of the embryo. These are: amnion, yolk sac, allantois and chorion. The amnion provides a fluid environment for the developing embryo and foetus. Firstly amnion is seen above the embryo; later on it surrounds the embryo. The yolk sac appears below the embryo. In humans, the yolk sac contains no yolk and is the first site of red blood cell formation. Part of this membrane becomes incorporated into the umbilical cord. The allantois contributes to the circulatory system. Its blood vessels become blood vessels of umbilical cord, which transport foetal blood to and from the placenta. Chorion, the outer extra embryonic membrane surrounds the embryo. It becomes the part of the placenta.
Placenta Development
The placenta is an organ that connects the developing foetus (fetus) to the uterine wall to allow nutrient uptake, waste elimination, and gas exchange via the mother's blood supply. In addition, the placenta is an endocrine organ that secretes hormones, progesterone and estrogen to maintain pregnancy. The placenta begins to develop upon implantation of the blastocyst into the maternal endometrium. The outer layer of the blastocyst becomes the trophoblast, which forms the outer layer of the placenta. The placenta grows throughout pregnancy. However, development of the maternal blood supply to the placenta is completed by the end of the first trimester of pregnancy (approximately 12 to 13 weeks). At this stage, hCG (human chorionic gonadotropin) declines, the corpus luteum degenerates and the placenta completely takes over the production of progesterone, which maintains pregnancy.

Major Events of Organogenesis
As the development of extraembryonic membranes and the placenta proceeds, the process of gastrulation and development of the embryo is also going on. At the end of the second month, the embryos tail has disappeared and the arms and legs are more developed with fingers and toes apparent. Internally all major organs have been appeared. Embryonic development is now finished. At the end of the embryonic period, all organ systems are established and there is a mature and functioning placenta. The embryo is only about 38 mm (1½ inch) long. After the first two months of development the embryo is referred to as a foetus. During the third month of pregnancy, the foetus grows rapidly. It is about 85 mm (3 1/3 inches) at the end of 1st trimester, differences between the sexes begin to take place.

Second Trimester
During the second trimester, the foetus grows to about 0.6 kg and 0.3 meter (1 foot) long. The four month old foetus looks quite human. Halfway through the fourth month, the foetus can bring the hand together and suck the thumb. At about 8th week many of the bones are forming by replacing the cartilages. By 15th week, the sensory organs are almost completely developed and by 16th week the foetus is actively turning inside the
mother.

By the end of the 5th month the heartbeat of the foetus can be heard through a stethoscope. At the end of the 6th month, the head is no longer quite as large compared with the rest of the body, they eyelids have separated and the lashes have formed. During the second trimester, the foetus grows to about 30cm and is very active. The mother may feel movements during the early part of the second trimester.

**Third Trimesters**

The third trimester is predominantly a period of growth rather than one of development. The weight of foetus doubles several times. The mother’s blood stream fuels all this growth by the nutrients it provides. As the end of development approaches the foetus usually rotates, so the head is pointed towards the cervix. At the end of the months, the foetus is about 540 mm (20 ½ inches) long.

**Q7. Describe in brief the development of twins and quadruplets.**

**Answer**

A pregnancy of two or more foetuses is called a multiple pregnancy. Multiple foetuses can be the same (identical) or different types (fraternal).

**Identical Twins**

Identical twins or triplets or quadruplets come from a single egg that has been fertilized by one sperm therefore also called monozygotic. For unknown reasons, the zygote splits into two or more embryos during the first stage of development. 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. Identical multiples are always of the same sex and blood type. They do not always look exactly alike. One may be right-handed while the other is left-handed and have different hand fingerprint due to exposure of different environment in later life.

![Diagram of Identical Twins versus Fraternal Twins](Fig. Identical Twins versus Fraternal Twins)

**Fraternal Twins**

Fraternal twins or triplets or quadruplets come from multiple eggs fertilized by different sperms therefore also called dizygotic or multiple zygotic. Fraternal foetuses have separate placenta and amniotic sacs. They can be of different sexes and have different blood types and may look very different from one another, with different
Q8. **Describe the structures details of placenta and umbilical cord.**

**Answer**

The placenta is the organ that provides nutrients and oxygen to the embryo and helps dispose of its metabolic wastes, formed of the embryos chorion and mothers endometrial blood vessels.

**Structure of placenta**

The structure of the placenta consists of tissue from foetal part and maternal part. The foetal part consists of chorionic villi. These increase surface area for absorption. The maternal part consist of projections from endometrium. These and chorionic villi are spaces supplied with arterial blood from arterioles in the uterus wall. Blood flows through the spaces from the arterioles to venules in the uterus wall. The placenta is a relating large structure, weighting on a average about 600 gram when fully formed and measuring 15-20 cm in diameter and 3 cm thick at the centre.

![Diagram of placenta and umbilical cord]

The foetal blood in the capillaries of the chorionic villi comes in close contact with the mothers blood in the tissues between villi. However, they are always separated by a membrane through which substances may diffuse or be actively transported. Maternal and foetal blood does not normally mix in the placenta or any other place.

**Umbilical cord**

As the human embryo grows, the umbilical cord (also called navel string) develops and connects the embryo to the placenta. The umbilical cord is physiologically and genetically part of the foetus and (in humans) normally contains two arteries (the umbilical arteries) and one vein (the umbilical vein). The umbilical vein supplies the foetus with oxygenated, nutrient-rich food from the placenta. Conversely, the foetal heart pumps deoxygenated, nutrient-depleted blood through the umbilical arteries back
to the placenta.

**Q9. Draw a table to list the events of human development in the first trimester, second trimester and third trimester.**

<table>
<thead>
<tr>
<th>Time</th>
<th>Events for Baby</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Trimester</strong></td>
<td></td>
</tr>
<tr>
<td>First Week</td>
<td>Fertilization occurs. Cell division begins and continues. Chorion appears.</td>
</tr>
<tr>
<td>Second Week</td>
<td>Impanation. Amnion and yolk sac appear. Embryo has tissues. Placenta begins to form.</td>
</tr>
<tr>
<td>Third Week</td>
<td>Nervous system begins development. Allantois and blood vessels are present.</td>
</tr>
<tr>
<td>Fourth Week</td>
<td>Limb buds form. Heart is noticeable and beating. Nervous system is prominent. Embryo has tail. Other systems form.</td>
</tr>
<tr>
<td>Fifth Week</td>
<td>Embryo is curved. Head is large. Limb buds show divisions. Nose, eyes, and ears are noticeable.</td>
</tr>
<tr>
<td>Sixth Week</td>
<td>Fingers and toes are present. Cartilaginous skeleton.</td>
</tr>
<tr>
<td>Two Months</td>
<td>All systems are developing. Bone is replacing cartilage. Refinement of facial features. Size reach up to 38 mm (1 ½ inch)</td>
</tr>
<tr>
<td>Third Month</td>
<td>Possible to distinguish sex. Finger nails appear.</td>
</tr>
<tr>
<td><strong>Second Trimester</strong></td>
<td></td>
</tr>
<tr>
<td>Fifth month</td>
<td>Protective cheesy coating begins to be deposited. Heartbeat can be heard.</td>
</tr>
<tr>
<td>Sixth month</td>
<td>Body is covered with fine hair. Skin is wrinkled and reddish.</td>
</tr>
<tr>
<td><strong>Third Trimester</strong></td>
<td></td>
</tr>
<tr>
<td>Seventh month</td>
<td>Testes descend into scrotum. Eyes are open.</td>
</tr>
<tr>
<td>Eight month</td>
<td>Body hair begins to disappear. Subcutaneous fat begins to be deposited.</td>
</tr>
<tr>
<td>Ninth month</td>
<td>Ready for birth.</td>
</tr>
</tbody>
</table>

**Q10. Describe the role of foetal and maternal hormones in initiating labour pains and culminating in the birth of baby.**

**Answer**

Partuion means birth of the baby. Toward the end of pregnancy, the uterus becomes progressively more excitable, until finally it develops such strong rhythmical contractions that the baby is expelled. There are several factor involved in the onset of
this excitation like increased ratio of estrogen to progesterone, fetal hormones and maternal hormones.

**Role of Hormones In Controlling Birth**

**Increased ratio of estrogen to progesterone**

Both progesterone and estrogen are secreted in progressively greater quantities throughout most of pregnancy, but from the seventh month onward, estrogen secretion becomes greater than progesterone secretion therefore called increased ratio of estrogens to progesterone. It stimulates the myometrial cells of the uterus to form abundant oxytocin receptors. As a result, the myometrium becomes increasingly irritable, and weak, irregular uterine contractions begin to occur. These contractions are called Braxton Hicks contractions or false labour pains.

**Role of foetal hormones in birth**

As birth nears, two more chemical signals cooperate to convert these false labour pains into the real thing. The foetal pituitary gland secretes increasing quantities of oxytocin, which might play a role in exciting the uterus. Pituitary gland also secrete ACTH that stimulates the foetal adrenal gland to relapses corticosteroids which affect two regions, first they influence the placenta and cause a decrease in progesterone production and second they stimulate the fetal membranes to produce an increased secretion of prostaglandins. Both oxytocin and prostaglandins are powerful uterine muscle stimulants, oxytocin causes contraction of the smooth muscles of the myometrium and prostaglandins increase the power of the contractions.

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**Role of Maternal Oxytocin in Birth**

At this point, the increasing emotional and physical stresses activate the mothers hypothalamus, which signals for oxytocin release by the posterior pituitary. Together the elevated levels of oxytocin and prostaglandins trigger the rhythmic expulsive contractions of true labour. Once the hypothalamus is involved, a positive feedback mechanism is propelled into action. The greater contractile force causes the release of
more oxytocin, which causes greater contractile force, and so on. The release of oxytocin occurs in waves during labour.

**Labour Process**

Braxton Hicks contractions become progressively stronger toward the end of pregnancy; then they change suddenly, within hours, to become exceptionally strong contractions that start stretching the cervix and later force the baby through the birth canal, thereby causing parturition. This process is called labour, and the strong contractions that result in final parturition are called labour contractions. The process of labour has three stages. The first stage is the opening up and thining of the cervix, ending with complete dilation. The second stage is the expulsion, or delivery, of the baby. Continuous strong contractions force the foetus down and out of the uterus and vagina. The final stage of the labour is delivery of the placenta, which normally follows the baby.

![Process of birth diagram]

**Clamping and cutting of umbilical cord**

After the delivery of the baby (second stage of the birth) the umbilical cord is still attached to the baby. The umbilical cord is clamped artificially as early as 1 to 5 minute after the birth of the child. Clamping is followed by cutting of the cord, which is painless due to the lack of any nerves.

**After Birth**

Following the birth of the foetus, usually within 10-15 minutes, the placenta separates from the uterine wall and is expelled by uterine contractions through the birth canal. This expulsion is termed the afterbirth.

**Q11. Define the term pre-mature birth and correlate it with growth phases in the second and third trimester.**

**Answer**
Premature Birth

Premature birth is also called preterm birth. It refers to the birth of a baby of less than 37 weeks of gestational age.

It is caused by many factors like: smoking, not getting good prenatal care, having health conditions, such as high blood pressure, diabetes, blood clotting disorders, or infections, being pregnant with a baby that has certain birth defects, being pregnant with a baby from in vitro fertilization and getting pregnant too soon after having a baby.

Depending on how premature a child is when they are born problems experienced by the baby may include: breathing problems due to immature lungs, difficulty in maintaining body temperature, feeding problems due to difficulty in sucking or coordinating breathing and swallowing, jaundice and increased risk of infections.

During second and third trimester when growth phase is dominant, if foetus is malnourished then growth is affected which may result in even pre-matured birth.

Q12. Compare breast feeding and bottle feeding in terms of advantages and disadvantages.

Answer

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 secretary 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 colostrums which is quite rich in antibodies. Usually, the baby is fed on the maternal milk for up to 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.

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.

Q13. Describe maternal derived abnormalities.

Answer

Maternal Derived Abnormalities

The disorders which are transmitted from mother to her baby during pregnancy or at the time of birth are called maternal derived abnormalities. Examples: rubella, neural tube defect, thyroid gland and limb development defect etc.

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 infected within the first 20 weeks of pregnancy, the child may be born with congenital rubella syndrome (CRS). Rubella virus can cause malformations of the eye 6th week of pregnancy (cataract); internal ear (congenital deafness due to destruction of the organ of Corti); heart 5th to 10th week of pregnancy (persistence of ductus arteriosus as well as the ventricular septal defects) and occasionally teeth 6th to 9th week of pregnancy (enamel layer).

Neural Tube Defects (NTDs)

Most defects of the spinal cord result from abnormal closure of the neural folds in the 3rd and 4th week of development. The resulting abnormalities are known as neural tube defects. Spina bifida refers to a splitting of the vertebral arches. Spina bifida occulta refers to a defect in the vertebral arches that is covered by skin. It occurs in the lumbosacral region. The defects are due to a lack of fusion of the vertebral arches. Spina bifida cystica is severe neural tube defects, in which neural tissue and meninges protrude through a defect in the vertebral arches and skin to form a cyst-like sac.
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.

Limb Development Defects
Abnormalities of the limbs vary greatly and may be represented by partial or complete absence of one or more of the extremities. Polydactyly can be inherited as a dominant trait but may also be induced by teratogen (which causes cancer). Abnormal fusion is usually restricted to fingers and toes. Cleft hand and foot consists of an abnormal cleft between the 2\textsuperscript{nd} and 4\textsuperscript{th} metacarpal bones and soft tissue. In clubfoot the sole of the foot is turned inward and the foot is adducted and planner flexed. Amniotic bands may cause ring constrictions of the limbs or digits and amputations.

![Limb development disorders](image)

Fig. Limb development disorders during embryonic development. (a) and (b) polydactyly (c) clubfoot (d) amniotic bands (e) cleft foot (f) cleft hand

Q14. Relate the major genetic abnormalities in embryos with spontaneous abortion.

Answer
Genetic Abnormalities and Spontaneous Abortion
Approximately 50 - 60\% of first trimester and 20\% of second trimester miscarriages are due to chromosomal abnormalities within the foetus. The factors leading to this cause include chromosomally abnormal sperm or egg, abnormal cell division of the foetus, and chromosomal abnormalities of mother and/or father.

Chromosomal abnormal sperm or egg will develop into a foetus that is genetically abnormal. Therefore, the woman’s body will reject the foetus and be a cause of miscarriage. Majority of these miscarriages will occur early in the pregnancy and a lot of women will not even know that they were pregnant.

Chromosomal abnormalities of the mother or father require special genetic testing and should be performed by a genetic counsellor. The genetic counsellor can evaluate the 23 pairs of chromosomes from both the mother and father and assess their risk for recurrent miscarriages. Most physicians require that a couple have at least two if not three miscarriages before referring them for genetic testing.

Q15.Describe how foetal surgery help to correct the detected foetal development problem?

Answer
Foetal Surgery for Development Problems

Foetal surgery is any of a broad range of surgical techniques that are used to treat birth defects in foetuses that are still in the pregnant uterus. There are two major ways of foetal surgery i.e. open foetal surgery and minimally invasive foetoscopic surgery.

Open Foetal Surgery
It involves complete opening of uterus to operate on the foetus. The conditions that potentially are treated by open foetal surgery include:

1) Foetal closure of neural tube defects
2) Congenital diaphragmatic hernia (if indicated at all, it is now more likely to be treated by endoscopic foetal surgery) etc..

Minimally Invasive Foetoscopic Surgery

Minimally-invasive foetoscopic surgery (or Fetendo) uses small incisions and is guided by foetoscopy and sonography. It has proven to be very useful for some, but not all, foetal conditions. Some examples include:

1) Foetal bladder obstructions
2) Aortic or Pulmonary Valvuloplasty: Opening the aortic or pulmonary foetal heart valves to allow blood flow.
3) Atrial Septostomy: Opening the inter-atrial septum of the foetal heart to allow unrestricted blood flow between the atria.

Q16. State changes that are the result of environmental, life style factors such as disease disuse and abuse as secondary aging.

Answer
The characteristics that are the result of environmental life style, factors such as disease, disuse and abuse are considered as secondary aging. The disuse is lack of
exercise and abuse includes smoking, obesity, malnutrition and exposure to ultra-violet light.

Q17. **Describe how a blastula is divided into two to produce twins of animals for biological research.**

**Answer**

A micromanipulator, is a device which is used to physically interact with a sample under a microscope, where a level of precision of movement is necessary that cannot be achieved by the unaided human hand. It may typically consist of an input joystick, a mechanism for reducing the range of movement and an output section with the means of holding micro tool to hold, inject, cut or otherwise manipulate the object as required. The best example of micromanipulation is the division of blastula in order to produce twin embryo for the purpose of biological research.

Q18. **Rationalize that nursing is an important bonding between mother and child, as it provides the child with protection by mother immune system while its own develops.**

**Answer**

During the first few weeks of life, a baby’s immune system is almost entirely dependent on the mother’s breast-milk for immune protection from its environment. The colostrums and mother’s milk contains the antibody IgA. When the mother comes in contact with a pathogen, or disease-causing agent, she synthesizes antibodies specific to that agent only. The immune system of a child does not reach its full strength until around the age of five. Demonstrating the unique bond a lactating mother has with her baby, a baby’s saliva actually communicates with the mother and literally affects the composition of the milk based on the baby’s unique needs. Breast feeding promotes bonding between mother and baby. Breast-feeding stimulates the release of the hormone oxytocin in the mother’s body. “It is now well established that oxytocin promotes the development of maternal behaviour and also bonding between mother and offspring.” It is important not to forget the incredible bond that is formed between mother and baby during the months that she is nursing is only the beginning of a deep bond they will share over a lifetime.

Q19. **List some of the disease due to aging and what medical science is doing to treat those diseases.**

**Answer**

**Osteoarthritis:** Anti-inflammatory drugs and painkillers are given in the early stages. Later a join replacement may be necessary.

**Osteoporosis:** Calcium intake is recommended in the form of medicine or food. Hormone therapy is recommended for most women after menopause if they wish to avoid problem.

**Arteriosclerosis:** Lifestyle changes, such as eating a healthy diet and exercising, are often and the best treatment for atherosclerosis. But sometimes, medication or surgical procedures may be recommended as well.
Q20. What changes take place during aging process?

Answer

The Changes that Occur During Aging

Changes at System Level

A decline in hormonal system can affect many organs of the body. For example, type II diabetes is common in older individuals. As aging occurs, skin becomes thinner and less elastic, because the number of elastic fibres and collagen fibres undergo cross-linkages. The heart shrinks because there is a reduction in cardiac muscle cell size. This leads to reduced cardiac output. There is reduced flow of blood to liver and this organ does not metabolize drugs. Circulatory problems are often accompanied by respiratory disorder and vice versa. There is also reduced blood supply to the kidneys. The kidney become smaller and less efficient in filtering waste. The loss of taste buds occurs. The digestive tract loses tone and secretion of saliva and gastric juice is reduced. Gastritis, ulcer and cancer can also occur. The number of neurons in the brain declines with age. There is decline in the speed of conduction of nerve impulse. Changes in locomotory system i.e., joints, skeletons, muscles and tendons occurs. Fertility in men gradually declines with age. in women it ends with menopause.

Changes at Cellular Level

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 of chromosomes where such changes as clumping, shrinkage and fragmentation occur. Other changes occur in such organelles as the mitochondria and lysosomes where numbers are reduced, causing cells to function less efficiently.

Q21. Describe a) Role of prolactin in the production of milk.
   b) Role of oxytocin in secretion of milk.

Answer

Lactation / Nursing

Lactation or nursing is secretion and yielding of milk by mother after giving birth. The milk is produced by the mammary glands, which are contained within the breasts. The first secretion of the breasts, following birth, is not milk but colostrums. This has a yellow colour. It is rich in the protein globulin. It contains little fat and less lactose than the milk. It provides nutrition and contains antibodies, particularly IgA that protects that nursing baby from infections.

Role of Prolactin in the production of milk

Rising levels of (placental) estrogen, progesterone, and lactogen toward the end of pregnancy stimulate the hypothalamus to release prolactin-releasing hormone (PRH). This in turn stimulates the anterior pituitary gland, which responds by secreting prolactin. Prolactin prepares the mammary glands for milk production. True milk production begins after a delay of two to three days of birth. Serotonin, a neurotransmitter, is synthesized by the mammary glands. It sends feedback signals to
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the hypothalamus that slow down prolactin release (and milk production) once the mammary glands are full of milk.

After birth, prolactin release gradually wanes (decrease), and continual milk production depends on mechanical stimulation of the nipples, normally provided by the sucking infant. Mechanoreceptors in the nipple send impulses to the hypothalamus, stimulating secretion of PRH. This results in a burst like release of prolactin, which stimulates milk production for the next feeding.

Role of Oxytocin in the Secretion of Milk
The sucking of the baby on the breast stimulates sensory receptors around and in the nipple. Nerve impulses pass from the receptors to the hypothalamus which also stimulate posterior pituitary to release oxytocin via a positive feedback mechanism. Oxytocin causes dilation of milk ducts and thus promotes ejection of milk from the alveoli of the mammary glands. During nursing oxytocin also stimulates the recently emptied uterus to contract, helping it to return to its pre-pregnant size.

As long as milk is removed from breasts, prolactin and oxytocin continue to be released. When nursing is discontinued, the stimulus for prolactin release and milk production ends, and within about one week, the mammary glands lose their capacity to produce milk.

Q22. Realize the effects of endocrine disrupting contaminants on the reproductive abilities.

Answer
The organs of endocrine system (including the pancreas, pituitary, thyroid and reproductive organs) produce variety of hormones, each of which triggers a specific biochemical response for example insulin regulates the body’s level of blood sugar, thyroid hormone is important for regulating the metabolic rate, and estrogen and testosterone control the development and functioning of reproductive organs.

The development and function of female reproductive tract depends upon hormone concentration and balance. Endocrine dysfunction may result in many abnormalities e.g. menstrual cycle irregularities, impaired fertility, endometriosis and polycystic ovarian syndrome (PCOs) and breast cancer. These abnormalities may result from modulation of the concentrations of estrogen and thyroid hormones. Some chemicals, both natural and man-made, can interfere with endocrine glands and their hormones or where the hormones act – the target tissues. These chemicals are called endocrine disrupting contaminants (EDCs) e.g., DDT. The presence of EDCs in our environment raises risk of some human reproductive disorders and some cancers which could be related to disturbance of the endocrine system. EDCs can act in a number of ways in different parts of the body, they may: (a) reduce the production of hormones in endocrine glands (b) affect the release of hormones from endocrine glands, (c) copy or counteract the action of hormones at target tissues, or (d) speed up the metabolism of hormones and so reduce their action.

Effect on Male Reproductive Ability
According to analysts, effects of endocrine disrupting contaminants on male reproductive abilities are:
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1) Sperm count declines by 42%
2) Semen volume declines by 18%

Q23. Beware of ethical implications of abortion.

Answer
The abortion debate is ongoing controversy surrounding the moral and legal status of abortion. The two main groups involved in the abortion debates are the:

i) Self described: Emphasizing the right of women to choose whether to abort a pregnancy or to grow it to term.

ii) Self described: Emphasizing the right of embryo or fetus to gestalt and be born.

Abortion is one of the most controversial issues associated with reproduction. It raises ethical issues. The commonly raised ethical issues are:

1) Abortion could be regarded as murder. Christians and Muslims believe that the soul is independent of the body and that it enters the body at the moment of conception.

2) Extra children may impose several financial stresses on an existing family.

3) Many abortions are carried out on foetuses with disabilities such as thallasemia, Down Syndrome etc..

Q24. Explain why proper nourishment of mother is imperative during third trimester of pregnancy.

Answer
The third trimester is a period of growth. The mother blood stream fuels all of this growth by nutrients it provides. Within placenta these nutrients pass into the foetal blood supply. If the foetus is malnourished because the mother is malnourished, this growth can be relatively affected. The result is the severely retarded infant; so proper nourishment of mother is necessary.

Q25. When oxytocin is involved in the secretion of milk, hypothesize why a new mother experience cramps in uterus while nursing?

Answer
The stimulus of sucking releases oxytocin. Oxytocin also stimulates contraction of the muscle in the uterus, helping it to recover its normal tone after birth, thus new mother often experience cramps in the uterus while nursing.

Q26. Using knowledge about postnatal growth rates of brain and jaw; interpret why six month old baby has the same jaw-skull proportion at the time of birth?

Answer
At the time of birth, the eight bones that make up the cranium are not yet fused together. This means that the skull can flex and deform during birth, making it easier to deliver a baby through the narrow canal. The individual plates of the bone fuse together after about eighteen months to form the adult skull.
Q27. List some of the diseases due to aging and what medical science is doing to treat those diseases?

Answer

**Osteoarthritis:** Anti-inflammatory drugs and painkillers are given in the early stages. Later a joint replacement may be necessary.

**Osteoporosis:** Calcium intake is recommended in the form of medicine or food. Hormone therapy is recommended for most women after menopause if they wish to avoid problem.

**Arteriosclerosis:** Lifestyle changes, such as eating a healthy diet and exercising, are often the best treatment for arteriosclerosis. But sometimes, medication or surgical procedures may be recommended as well.

Q28. Rationalize that nursing is an important bonding between mother and child, as it provides the child with protection by mother immune system while its own develops.

Answer

During the first few weeks of life, a baby’s immune system is almost entirely dependent on the mother’s breast milk for immune protection from its environment. The colostrums and mother’s milk contains the antibody IgA. When the mother comes in contact with a pathogen, or disease-causing agent, she synthesizes antibodies specific to that agent only. The immune system of a child does not reach its full strength until around the age of five. Demonstrating the unique bond a lactating mother has with her baby, a baby’s saliva actually communicates with the mother and literally affects the composition of the milk based on the baby’s unique needs. Breast feeding promotes bonding between mother and baby. Breast-feeding stimulates the release of the hormone oxytocin in the mother’s body. “It is now well established that oxytocin promotes the development of maternal behaviour and also bonding between mother and offspring.” It is important not to forget the incredible bond that is formed between mother and baby during the months that she is nursing is only the beginning of a deep bond they will share over a lifetime.
Q29. What are the factors responsible for aging and what are signs and symptoms of aging.

Answer

Factors Responsible for Aging
There are many theories about what causes aging. Two of these, the genetic and extrinsic factors are considered here.

Genetic Factor
Several evidences have been discovered that show aging has a genetic basis. Experiments have shown that human cells will divide less than 100 times outside the body. This is because of short length of telomeres, the specific nucleotide sequences at the end of chromosomes. When we are conceived our telomeres are full length but each time a cell divides, the length of telomeres is decreased (like the way lead in a pencil wears down when you write with it). If these sequences are shortened to a critical length, the cell is no longer able to divide. When cells cannot divide, damaged tissues cannot regenerate and we begin to wear out.

Extrinsic Factor
Aging is due to years of poor health habits. Osteoporosis is the progressive decline in bone density as result fracture is most likely to occur. While there is no denying that osteoporosis occurs as result of aging, certain extrinsic factor are also important. The occurrence of osteoporosis itself is associated with cigarette smoking, heavy alcohol intake and perhaps inadequate calcium intake. A moderate exercise program has been found to slow down the progressive loss of bone mass. If the diet includes fruits and vegetables, good health habits sensible exercise will most likely help to eliminate cardiovascular disease, the leading cause of death today.

Signs and Symptoms of Aging
There are different signs and symptoms of aging. Most of these develop gradually and different people possess varying degrees of these signs and symptoms which can be divided into two groups i.e., primary aging and secondary aging.

Primary Aging
As aging occurs there are fewer hair follicles, so the hair on the scalp and extremities thins out. Older people experience a decrease in the number of melanocytes, making hair grey and skin pale. In contrast, some of the remaining pigment cells are larger and pigmented blotches appear in skin. The immune system, too no longer performs as it once did and this causes decreased resistance to infection. The other effects of aging are: deafness (in particular lack of ability to hear high notes), fading vision, and reduced ability to adapt to stress. It is important to remember that different individuals can be affected to different extent.

Secondary Aging
The characteristics that are the result of environmental, life style factors such as
diseases, disuse and abuse are considered is secondary aging. The disuse is the lack of exercise and abuse include smoking obesity, malnutrition and exposure to ultra violet light.

**KEY POINTS**

- An organism changes from a fertilized egg into an adult. The progressive changes which are undergone before and 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 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 fetuses is called multiple pregnancies.
- 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 characterized by degeneration of organ systems and tissues with consequent loss of functional reserve of these systems.