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Development, Heredity, and Aging

FOCUS: The prenatal development period can be divided into three portions: the germinal period, during which implantation and germ layer formation occur; the embryonic period, during which organ systems are formed; and the fetal period, during which most of the organ systems grow and mature. Aging, like development, begins at fertilization. Cellular and tissue changes occur during the process of aging. Human genetics, the study of inherited human traits, is necessary to understand, predict, and prevent genetic birth defects.

CONTENT LEARNING ACTIVITY

Prenatal Development

"*The prenatal period, the period from conception to birth, can be divided into three parts.*"

A. Match these terms with the correct statement or definition:

Embryonic period
Fetal period
Germinal period

_____ 1. First two weeks of development; germ layers are formed.

_____ 2. Second to eighth week of development; organ systems formed.

_____ 3. Last seven months of the prenatal period.

B. Match these terms with the correct statement or definition:

Clinical age
Developmental age

_____ 1. Age of unborn child, using last menstrual period (LMP).

_____ 2. Timing of developmental events based on time of fertilization.

C. Match these terms with the correct statement or definition:

Capacitation	23
Fertilization	46
Secondary oocyte	Zygote

_____ 1. Process that allows sperm cell to release enzymes that allow penetration of the sperm cell into the secondary oocyte.

_____ 2. Female sex cell, which can be fertilized by a sperm cell.

_____ 3. Number of chromosomes in the nucleus of a secondary oocyte and in the nucleus of a sperm cell.

_____ 4. Union of sperm cell and secondary oocyte.

_____ 5. A single cell that is the product of fertilization.

D. Match these terms with the correct statement or definition:

Blastocele	Inner cell mass
Blastocyst	Trophoblast

_____ 1. Embryonic mass of cells with an internal cavity; occurs at about the 32 cell stage.

_____ 2. Fluid-filled cavity of the blastocyst.

_____ 3. Thickened area at one end of the blastocyst; develops into the embryo.

_____ 4. Single layer of cells surrounding most of the blastocele; forms the placenta and embryonic membranes.

Implantation of the Blastocyst and Development of the Placenta

"*Early germinal phase events occur as the embryonic mass moves from the uterine tube to the site of implantation in the uterus.*"

A. Using the terms provided, complete these statements:

Chorion	Implantation
Chorionic villi	Lacunae
Human chorionic gonadotropin (HCG)	Placenta
	Umbilical cord

About 7 days after fertilization, the trophoblast attaches itself to the uterine wall, and begins a process called (1). The trophoblast cells, which are now called the (2), form the embryonic portion of the (3) as the uterine wall is invaded. Fingerlike projections, called (4), protrude into cavities called (5), which contain pools of maternal blood, formed within the maternal endometrium. The connecting stalk between the embryo and placenta elongates and becomes known as the (6). The chorion secretes (7), which causes the corpus luteum in the ovary to remain functional.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

The developing human between 14 and 56 days of development is called an embryo.

B. Match these terms with the correct statement or definition:

Amniotic cavity	Mesoderm
Ectoderm	Notochord
Embryonic disk	Primitive streak
Endoderm	Yolk sac

_____ 1. New, fluid-filled cavity formed in the inner cell mass after implantation.

_____ 2. Flat disk of tissue formed from the inner cell mass; consists of two layers of cells.

_____ 3. Layer of cells on the side of the embryonic disk opposite the amniotic cavity.

_____ 4. Third embryonic cavity, formed from endoderm, inside the blastocele.

_____ 5. Thickened line formed as proliferating ectoderm cells migrate toward the center of the disk.

_____ 6. Germ layer; forms between ectoderm and endoderm.

_____ 7. A cordlike structure formed when a specialized group of cells moves from one end of the primitive streak to the other.

The amniotic cavity is surrounded by a membrane called the amniotic sac and is filled with amniotic fluid.

Neural Tube and Neural Crest Formation

"*The neural tube and neural crest become the nervous system and parts of the head.*"

Match these terms with the correct statement or definition:

Neural crest cells	Neural plate
Neural folds	Neural tube
Neural groove	Neuroectoderm

_____ 1. Thickened layer of ectoderm overlying the notochord.

_____ 2. Lateral edges of the neural plate that rise and come together.

_____ 3. Area between the two neural folds.

_____ 4. Structure formed when neural crests meet in the midline and fuse.

_____ 5. Cells of the neural tube; become the brain, spinal cord, and parts of peripheral nervous system.

_____ 6. A population of cells that breaks away along margins of the folds; becomes part of peripheral nervous system, melanocytes, and parts of the head.

Formation of the General Body Structure

"*The arms and legs first appear at about 28 days, and the face is distinctly human by 56 days after fertilization.*"

A. Match these terms with the correct statement or definition:

Foramen ovale
Interatrial septum
Interventricular septum
Limb buds
Organogenesis

_____ 1. Structures that develop into arms and legs.

_____ 2. Period during which the major organ systems appear and begin to develop.

_____ 3. Structure that divides the ventricles of the heart.

_____ 4. Opening in the interatrial septum; allows blood to flow from the right atrium to the left atrium.

If the two masses forming the upper jaw and lip fail to fuse, a cleft lip results. If the palate does not fuse, a midline cleft in the roof of the mouth called a cleft palate results.

B. Using the terms provided, complete these statements:

Embryonic
Fat
Fetal
Lanugo
Placenta
Vernix caseosa

The beginning of the (1) period is marked by bone ossification. In the (2) period, most of the organ systems are developing, whereas in the (3) period the organs are present. Fine, soft hair called (4) covers the fetus, and a waxy coat of sloughed epithelial cells called the (5) protects the fetus. Subcutaneous (6) that accumulates in the fetus provides a nutrient reserve, helps insulate, and aids the newborn in sucking. Growth of the (7) stops at 35 weeks, restricting further growth of the fetus.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Parturition

"*Parturition (the birth process) is calculated to be 280 days from the last menstrual period (LMP).*"

A. Match these terms with the correct statement or definition:

First stage of labor
Second stage of labor
Third stage of labor

_____ 1. From the onset of regular contractions until the cervix dilates to 10 cm.

_____ 2. From the time of maximal cervical dilation until the baby exits the vagina.

_____ 3. Expulsion of the placenta from the uterus.

B. Match these hormones with the correct statement or definition:

ACTH
Estrogen
Oxytocin
Progesterone
Prostaglandins

_____ 1. Hormone that inhibits uterine muscle contraction.

_____ 2. Hormones that directly stimulate uterine smooth muscle.

_____

_____

_____ 3. Fetal pituitary hormone; stimulates the adrenal gland to secrete cortical steroids, which in turn increase estrogen and prostaglandin secretion.

The Newborn

"*The newborn infant, or neonate, experiences several dramatic changes at the time of birth.*"

A. Match these terms with the correct statement or definition:

Ductus arteriosus
Ductus venosus
Foramen ovale
Umbilical arteries and vein

_____ 1. Opening between right and left atria that closes at birth.

_____ 2. Short artery that connects the aorta with the pulmonary trunk.

_____ 3. Fetal vessels through which blood passes to, and returns from, the placenta.

_____ 4. Vessel that bypasses the liver sinusoids.

B. Match these terms with the correct statement or definition:

Colostrum
Lactase
Meconium
Oxytocin
Prolactin
Surfactant

_____ 1. Substance that coats the inner surface of the alveoli; reduces surface tension of the lungs.

_____ 2. Greenish anal discharge in the newborn.

_____ 3. Enzyme in the small intestine that digests milk sugar.

_____ 4. Secretion from the mammary glands for the first few days following parturition; contains little fat and less lactose than milk.

_____ 5. Anterior pituitary hormone that stimulates milk production.

_____ 6. Posterior pituitary hormone produced in response to mechanical stimulation of the breast; induces milk "letdown".

The First Year Following Birth

"*A great number of changes occur in the infant from the time of birth to 1 year of age.*"

Match these ages with the correct level of development.

Eight months
Five months
Six Weeks
Twelve months

_____ 1. Infant may be able to walk and say several words.

_____ 2. Baby can hold up his or her head and smile.

_____ 3. Infant can sit with support, laugh out loud, turn her head to follow an object, and roll over.

_____ 4. Infant can recognize people, sit without support and reach for specific objects.

Life Stages

"*Life can be divided into at least eight stages from fertilization to death.*"

Match these life stages with the correct definition:

Adolescence
Adult
Childhood
Embryo
Fetus
Germinal
Infant
Neonatal

_____ 1. Period from birth to one month after birth.

_____ 2. Period from one month after birth to one or two years.

_____ 3. Period from one or two years after birth to puberty.

_____ 4. Period from puberty to 20 years.

_____ 5. Period from 20 years to death.

Aging

"*The process of aging begins at fertilization.*"

Using the terms provided, complete these statements:

Atherosclerosis	Embolus
Arteriosclerosis	Filtration
Autoimmunity	Free radical
Collagen	Heart
Cellular aging	Stress
Decrease	Thrombosis

As the individual ages, more and more cross-links are formed between (1) molecules, rendering the tissues more rigid and less flexible. Death or damage to a nondividing cell produces irreversible damage; as a result, the number of muscle cells and neurons (2) with age. The (3) loses elastic recoil ability and muscular contractility, causing a decline in cardiac output. Reduced cardiac function may also result in decreased blood flow to the kidneys, causing a decrease in (4). (5) is the deposit of lipids in the tunica intima of large and medium-sized arteries. These deposits become fibrotic and calcified, which contributes to (6), which interferes with normal blood flow and may lead to a (7) (a clot or plaque formed inside a vessel). A piece of plaque, called a(n) (8) can break loose and lodge in smaller arteries, causing heart attacks or strokes. (9), or cellular wear and tear, is another factor that contributes to aging. According to the (10) theory of aging, free radicals (atoms or molecules with an unpaired electron) react with and alter the structure of critical molecules. Either losing the ability to respond to a foreign antigen or (11) (responding to one's own antigens) may be part of the aging process. A great disadvantage of aging is the increasing lack of ability to adjust to (12).

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Whole brain death is manifested clinically by the absence of response to stimulation, the absence of natural respiration and heart function, and an isoelectric ("flat") electroencephalogram for at least 30 minutes (in the absence of CNS poisoning or hypothermia).

Genetics

"*Human genetics is the study of characteristics inherited by children from their parents.*"

A. Match these terms with the correct statement or definition:

Chromosomes	Meiosis
Gametes	Somatic cells

_____ 1. Densely stained bodies that become visible during cell division; DNA molecules and their associated proteins.

_____ 2. All the cells of the body, except sex cells.

_____ 3. Sex cells; contain 23 unpaired chromosomes.

_____ 4. Process by which gametes are produced; reduction division.

The display of chromosomes from a somatic cell is called a karyotype.

B. Match these terms with the correct statement or definition:

one pair
22 pairs
23 pairs

_____ 1. Total number of chromosomes in a human somatic cell.

_____ 2. Number of sex chromosomes in each human somatic cell.

_____ 3. Number of autosomal chromosomes in each human somatic cell.

A normal female has two X chromosomes in each somatic cell (XX), whereas a normal male has one X chromosome and one Y chromosome (XY)

C. Match these terms with the correct statement or definition:

Alleles
Gene
Genome
Heterozygous
Homologous
Homozygous

_____ 1. Two chromosomes that contain the same complement of genetic information.

_____ 2. The functional unit of heredity; thousands are on each chromosome.

_____ 3. Similar genes on homologous chromosomes.

_____ 4. Two allelic genes for a trait are identical in one person.

_____ 5. Two alleles for a trait that are slightly different in one person.

_____ 6. All of the genes in one homologous set of 23 chromosomes in a single individual.

Through the process of meiosis, gamete formation, and fertilization the distribution of genes received from each parent is essentially random.

D. Match these terms with the correct statement or definition:

Crossing over
Down syndrome (trisomy 21)
Linked

_____ 1. Genes on a chromosome tend to be inherited as a set, rather than individual genes.

_____ 2. Exchange of genetic information between homologous chromosomes during meiosis.

_____ 3. Abnormality that occurs when a segregation error happens during meiosis.

E. Match these terms with the correct statement or definition:

Dominant
Genotype
Phenotype
Recessive

_____ 1. A gene that is expressed only when not masked by its allele.

_____ 2. The alleles a person has for a given trait.

_____ 3. A person's appearance.

Probabilities of the inheritance of dominant and recessive traits can be easily determined by the use of a table called a Punnett square.

F. Match these terms with the correct statement or definition:

Carrier
X-linked
Y-linked

_____ 1. Person with an abnormal gene, but a normal phenotype.

_____ 2. Trait affected by a gene on the X chromosome.

G. Match the types of inheritance with the correct definition:

Codominance
Incomplete dominance
Polygenic traits

_____ 1. The dominant gene does not completely mask the effects of the recessive gene; e.g., sickle cell anemia.

_____ 2. Two alleles combine to produce an effect without either being dominant or recessive, e.g., ABO blood types.

_____ 3. Determined by multiple genes on different chromosomes, e.g., height, intelligence, skin color, and eye color.

H. Match these terms with the correct statement or definition:

Cancer
Carcinogens
Genetic counseling
Genetic susceptibility (genetic predisposition)
Oncogenes
Pedigree

_____ 1. A tumor resulting from uncontrolled cell division.

_____ 2. Genes associated with cancer; control genes regulating cell division and differentiation.

_____ 3. Chemicals that can induce changes in oncogenes and initiate cancer development.

_____ 4. A genetic basis that allows the development of certain disorders under the right environmental conditions.

_____ 5. Predicting the possible results of matings involving carriers of harmful genes and talking to parents about possible outcomes and treatments of genetic disorders.

_____ 6. A chart that provides historical genetic information about a family; a family tree.

QUICK RECALL

1. List these structures in the order in which they form during development: blastocyst, embryonic disk, mesoderm, primitive streak, zygote.

2. Name the three germ layers from which all adult tissues develop.

3. Name the periods during which these events occur: formation of three germ layers; organogenesis; growth and maturation of organ systems.

4. List four hormones that influence uterine contractions.

5. List three changes that occur in the circulatory system of the newborn.

6. List the eight life stages.

7. List four factors in aging.

WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
nata-	birth	1. _____
neo-	new	2. _____
blast-	a bud	3. _____
-cyst	bladder; sac	4. _____
-cele	hollow	5. _____
meso-	middle	6. _____

MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

_____ 1. The major development of organs takes place in the
a. organ period.
b. fetal period.
c. germinal period.
d. embryonic period.

_____ 2. Given these structures:
1. blastocyst
2. embryonic disk
3. zygote
Choose the arrangement that lists the structures in the order in which they are formed during development.
a. 1,2,3
b. 1,3,2
c. 2,3,1
d. 3,1,2
e. 3,2,1

_____ 3. The placenta
a. develops from the trophoblast.
b. allows maternal blood to mix with embryonic blood.
c. invades the lacunae of the embryo.
d. all of the above

_____ 4. The embryo develops from the
a. inner cell mass.
b. trophoblast.
c. blastocele.
d. yolk sac.

_____ 5. The brain develops from
a. endoderm.
b. ectoderm.
c. mesoderm.

_____ 6. Given these structures:
1. neural folds
2. neural plate
3. neural tube

Choose the arrangement that lists the structures in the order in which they form during development.
a. 1,2,3
b. 1,3,2
c. 2,1,3
d. 2,3,1
e. 3,2,1

_____ 7. During the fetal period
a. most organ systems enlarge and mature.
b. little increase in length or weight occurs.
c. a waxy coat of epithelial cells called lanugo covers the fetus.
d. all of the above

_____ 8. Which of these hormones has an inhibitory effect on uterine smooth muscle?
a. estrogen
b. prostaglandins
c. oxytocin
d. progesterone

_____ 9. Which of these is an opening in the interatrial septum that closes after birth?
a. ductus arteriosus
b. foramen ovale
c. ductus venosus
d. umbilical vein

_____ 10. The hormone responsible for milk production in the breasts is
a. estrogen.
b. progesterone.
c. oxytocin.
d. prolactin.
e. both a and b

_____ 11. Given these life periods:
1. embryo
2. fetus
3. germinal
4. neonate

Choose the arrangement that lists the life periods in the correct order.
a. 1,2,3,4
b. 1,3,2,4
c. 3,1,2,4
d. 3,2,1,4

_____ 12. Aging occurs because
a. non-dividing cells are damaged or die.
b. collagen cross-links form, decreasing flexibility.
c. skeletal muscle cells decline in number.
d. cardiac muscle function declines.
e. all of the above

_____ 13. In humans, gametes contain
a. no chromosomes.
b. 23 unpaired chromosomes.
c. only X chromosomes.
d. 23 pairs of chromosomes.

_____ 14. A gene is
a. the functional unit of heredity.
b. a certain portion of a DNA molecule.
c. a part of a chromosome.
d. all of the above

_____ 15. Which of these genotypes is heterozygous?
a. DD
b. Dd
c. dd
d. both a and c

_____ 16. A carrier is a person with
a. a homozygous genotype of an abnormal gene.
b. homozygous genotype without an abnormal gene.
c. a heterozygous genotype with an abnormal gene.
d. a heterozygous genotype without an abnormal gene.

_____ 17. If "A" is a gene for normal skin color, and "a" is the gene for albinism, a woman with the genotype "aa"
a. is an albino.
b. is a carrier for albinism.
c. cannot pass the gene for albinism to her children.
d. can become an albino later in life.

_____ 18. Height and skin color are examples of
a. codominance.
b. X-linked traits.
c. oncogenes.
d. incomplete dominance.
e. polygenic traits.

_____ 19. Red-green color-blindness is an X-linked recessive trait. If a woman is color-blind, but her husband is not, what is the probability their children will be color-blind?
a. 0 (no chance)
b. 1/4
c. 1/2
d. 3/4
e. 4/4 (all)

_____ 20. What is the probability that parents who are both carriers for albinism will have an albino child?
a. 0 (no chance)
b. 1/4
c. 1/2
d. 3/4
e. 4/4 (all)

FINAL CHALLENGES

Use a separate sheet of paper to complete this section.

1. If a woman contracts rubella (German measles) while pregnant, the baby may be born with a congenital disorder such as cataracts, deafness, or cardiac malform-ation. If the mother is infected in the first month of pregnancy versus the third month what effect would this time difference have on the likelihood that the baby will have a congenital disorder?

2. When a woman nurses, it is possible for milk letdown to occur in the breast that is not being suckled. Explain how this response happens.

3. In some women, lactation prevents the ovarian cycle for a few months after parturition. Given that suckling causes nerve impulses to travel from the nipples to the hypothalamus, suggest how the ovarian cycle is prevented.

4. Is a person with the abnormal genotype XXXY male or female? Explain.