

MEDICAL EMBRYOLOGY

INTRODUCTION

GAMETOGENESIS

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Board

Clinical surgical anatomy

F.I.M.B.S-MB.CH.B

Medical embryology

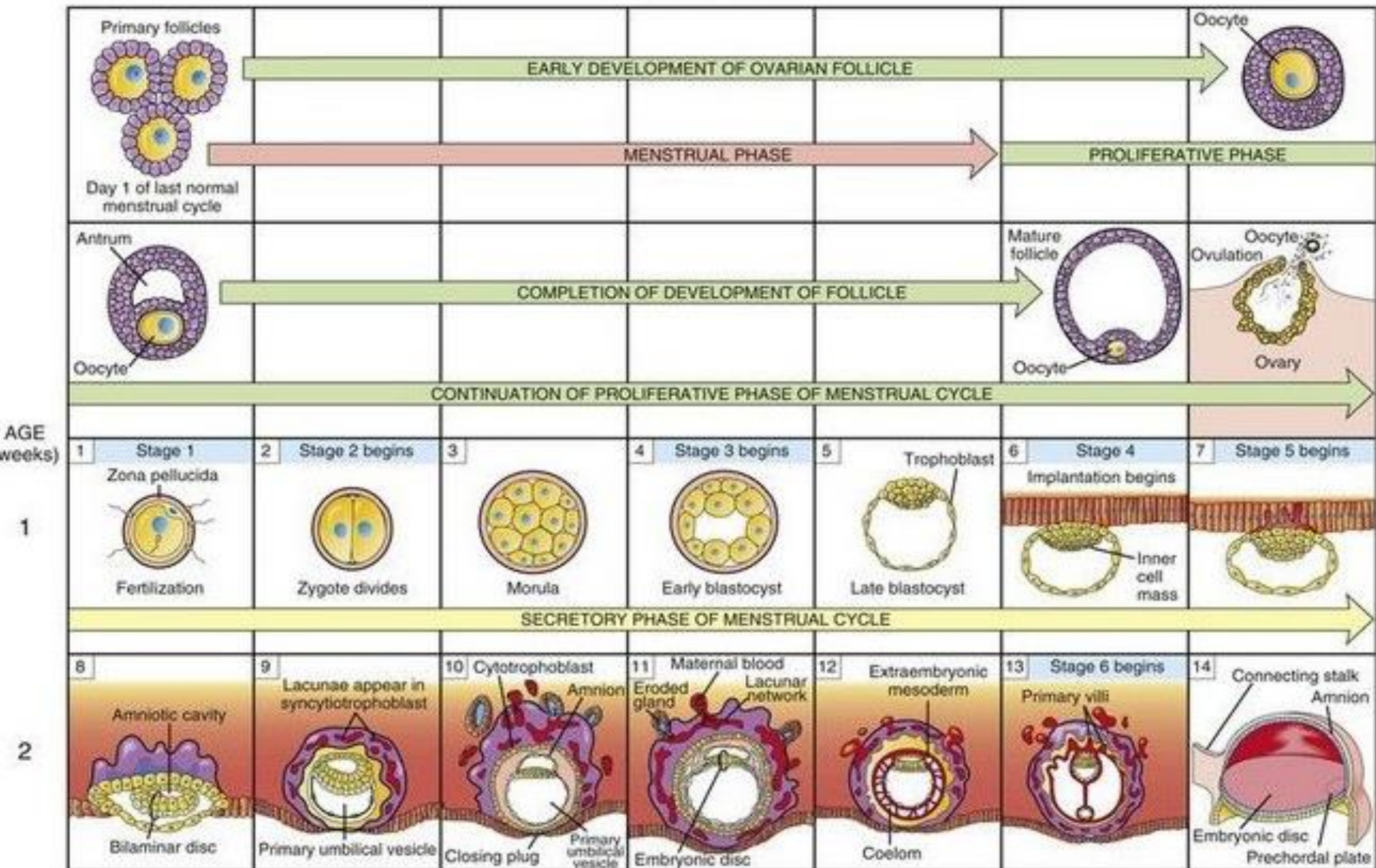
- Embryology: **prenatal development of embryos and fetuses. So it means the study of the developmental process starting from a single cell to a baby in 9 months of age.**
- **Objective**
- It includes investigation of molecular, cellular and structural factors contribute to the formation of an organism.
- Health care strategies for better reproductive outcomes.
- used to diagnose, care, and prevent birth defects

Developmental Periods


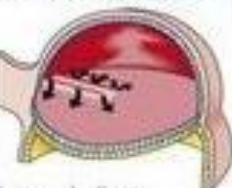
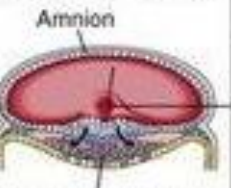
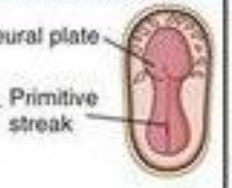
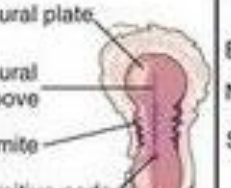



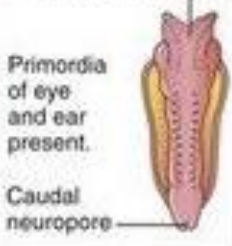

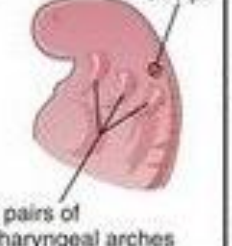
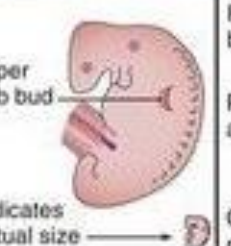
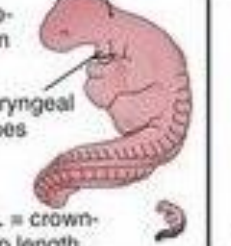
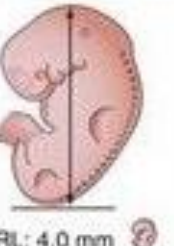
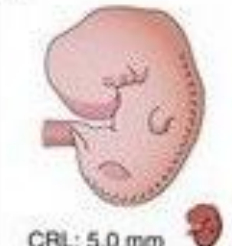
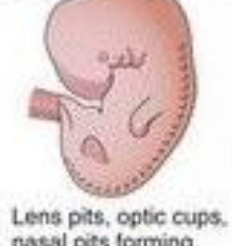
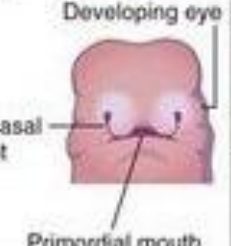
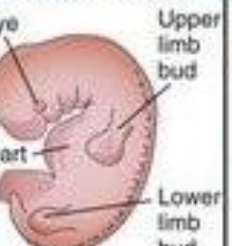
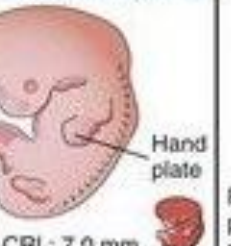
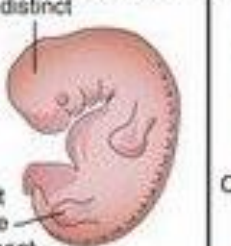

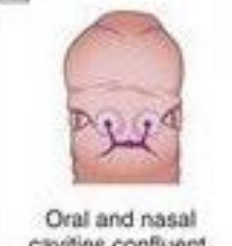
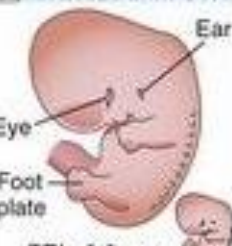
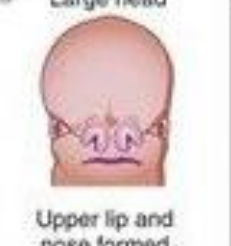

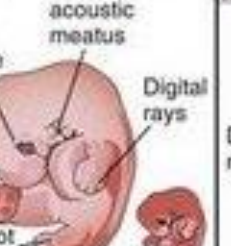
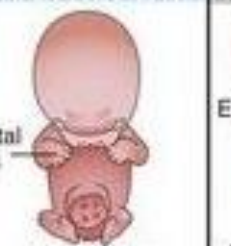

- Human development divided into:
- ***prenatal (before birth) and***
- ***postnatal (after birth) periods.***
- Most changes occur during embryonic and fetal periods. Important changes occur during later periods of development: infancy, childhood, and adolescence.
- Other changes, in addition to growth, occur after birth (e.g., development of teeth and female breasts)

Developmental Periods

TIMETABLE OF HUMAN DEVELOPMENT
1 TO 10 WEEKS



Developmental Periods

<p>15 First missed menstrual period</p>  <p>Primitive streak</p>	<p>16 Stage 7 begins</p>  <p>Arrows indicate migration of mesenchymal cells.</p>	<p>17 Trilaminar embryo</p>  <p>Amnion Primitive streak Migration of cells from primitive streak.</p>	<p>18 Stage 8 begins</p>  <p>Neural plate Primitive streak Length: 1.5 mm</p>	<p>19</p>  <p>Neural plate Neural groove Somite Primitive node Primitive streak</p>	<p>20 Stage 9 begins</p>  <p>Brain Neural groove Somite Thyroid gland begins to develop.</p>	<p>21</p>  <p>Neural groove First pairs of somites Primitive streak</p>
<p>22 Stage 10 begins</p>  <p>Heart begins to beat Neural folds fusing.</p>	<p>23 Rostral neuropore</p>  <p>Primordia of eye and ear present. Caudal neuropore</p>	<p>24 Stage 11 begins</p>  <p>Heart bulge Rostral neuropore closes 2 pairs of pharyngeal arches</p>	<p>25</p>  <p>Otic pit 3 pairs of pharyngeal arches</p>	<p>26 Stage 12 begins</p>  <p>Upper limb bud Indicates actual size</p>	<p>27 Site of otic (ear) pit</p>  <p>Fore-brain Pharyngeal arches CRL = crown-rump length.</p>	<p>28 Stage 13 begins</p>  <p>CRL: 4.0 mm</p>
<p>29</p>  <p>CRL: 5.0 mm</p>	<p>30</p>  <p>Lens pits, optic cups, nasal pits forming.</p>	<p>31</p>  <p>Developing eye Nasal pit Primordial mouth</p>	<p>32 Stage 14 begins</p>  <p>Eye Upper limb bud Heart Lower limb bud</p>	<p>33 Stage 15 begins</p>  <p>Hand plate CRL: 7.0 mm</p>	<p>34 Cerebral vesicles distinct</p>  <p>Foot plate present</p>	<p>35 Eye</p>  <p>Cord CRL: 8.0 mm</p>
<p>36</p>  <p>Oral and nasal cavities confluent.</p>	<p>37 Stage 16 begins</p>  <p>Eye Ear Foot plate CRL: 9.0 mm</p>	<p>38 Large head</p>  <p>Upper lip and nose formed.</p>	<p>39</p>  <p>CRL: 10.0 mm</p>	<p>40 External acoustic meatus</p>  <p>Eye Digital rays Foot plate</p>	<p>41 Stage 17 begins</p>  <p>Digital rays Ventral view</p>	<p>42</p>  <p>Eye Ear CRL: 13.0 mm</p>

Developmental Periods

AGE
(weeks)

7

43	Actual size CRL: 16 mm	44 Stage 18 begins Eyelids forming	45 Head large but chin poorly formed. Grooves between digital rays indicate fingers.	46 Wall of uterus Amniotic sac Uterine cavity Smooth chorion	47 Genital tubercle Urogenital membrane Anal membrane ♀ or ♂	48 Stage 19 begins Eyelid External ear Wrist, fingers fused	49 Actual size CRL: 18 mm
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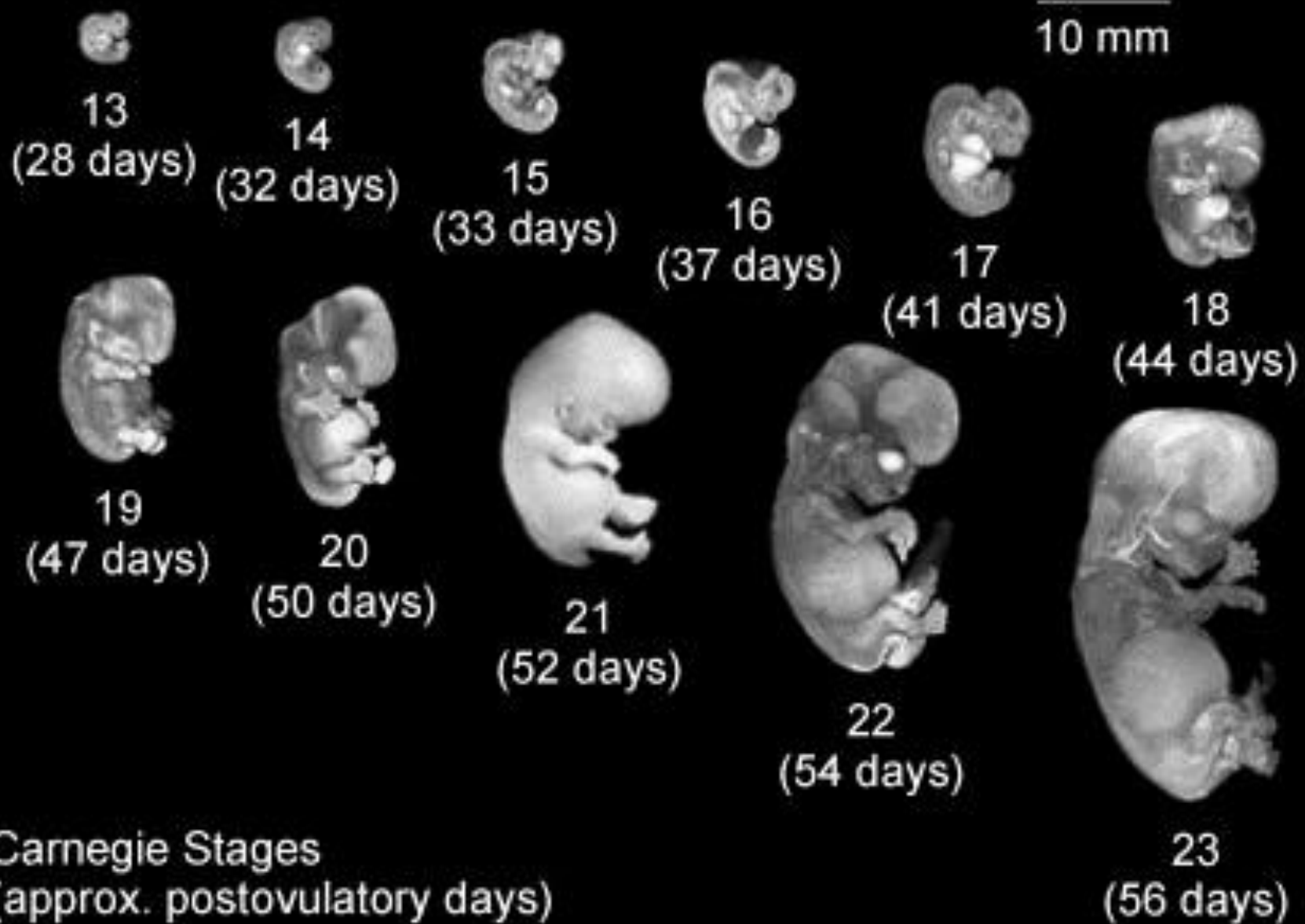
50 Stage 20 begins Upper limbs longer and bent at elbows. Fingers distinct but webbed.	51 Eye Ear Nose Fingers Toes	52 Stage 21 begins Large forehead	53 External genitalia have begun to differentiate.	54 Stage 22 begins Genital tubercle Urethral groove Anus ♀ or ♂	55 Eye Ear Wrist Knee Elbow Toes	56 Stage 23 CRL: 30 mm
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9

57 Beginning of fetal period.	58 Eye Ear Wrist Knee Elbow Toes	59 Placenta Placenta	60 Genitalia Phallus Urogenital fold Labioscrotal fold Perineum ♀	61 CRL: 45 mm	62 Genitalia Phallus Urogenital fold Labioscrotal fold Perineum ♂	63 CRL: 50 mm
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10

64 Face has human profile. Note growth of chin compared to day 44.	65 Face has human profile. Note growth of chin compared to day 44.	66 Ears still lower than normal.	67 Clitoris Labium minus Urogenital groove Labium majus ♀	68 Genitalia have ♀ or ♂ characteristics but still not fully formed.	69 Glans penis Urethral groove Scrotum ♂	70 CRL: 61 mm
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Objective

- At the end of each chapter is a that serves as a concise review of the key points described in detail throughout the chapter.

- **Problems to Solve:**

These problems test a student's ability to apply the information covered in a particular chapter.

TERMINOLOGY


- **Conceptus:** derivatives of zygote. Represents the embryo and its appendages or associated membranes (i.e. the products of conception). It includes all structures that develop from the zygote, both embryonic and extra-embryonic.
- **Trimester:** A period of 3 months, one third of the length of a pregnancy. Used by Obstetricians.
- **Abortion:** premature stoppage of development and expulsion of a conceptus from the uterus or expulsion of an embryo or fetus before it is viable.
- **Miscarriage:** spontaneous abortion of a fetus and its membranes before the middle of the second trimester (approximately 135 days)

TERMINOLOGY

- **Prenatal period:** period of pregnancy or before birth. It includes:
 - The process of progressing from a single cell through the period of establishing organ primordia (the first 8 weeks of human development) is called the period of embryogenesis (sometimes called the period of organogenesis)
- 1. **Embryonic period:** 3rd -8th week of pregnancy.
- 2. **Fetal period:** beginning of 9th week till birth.
- **Postnatal period:** after birth, it include the following developmental terms:
 - 1. **Infancy:** earliest period of extra-uterine life, roughly the first year after birth.
 - 2. **Newborn or Neonate:** infant aged 1 month or younger.
 - 3. **Childhood:** The period between infancy and puberty

TERMINOLOGY

4. **Puberty:** when humans become functionally capable of reproduction through development of reproductive organs.
 5. **Adulthood:** achievement of full growth and maturity is generally reached between the ages of 18 and 21 years.
 6. The study of the embryological origins and causes for these birth defects was called **teratology**.
- INTRODUCTION TO MOLECULAR REGULATION AND SIGNALING
 - Molecular biology has opened the doors to new ways to study embryology and to enhance our understanding of normal and abnormal development. Sequencing the human genome, together with creating techniques to investigate gene regulation at many levels of complexity, has taken embryology to the next level

- 
- There are approximately 35,000 genes in the human genome, which represents only one third of the number predicted prior to completion of the Human Genome Project.
 - Because of various levels of regulation, however, the number of proteins derived from these genes is closer to the original predicted number of genes.
 - What has been disproved is the one-gene-one-protein hypothesis. Thus, through a variety of mechanisms, a single gene may give rise to many proteins.

Gene expression can be regulated at several levels

- (1) different genes may be transcribed,
- (2) nuclear deoxyribonucleic acid (DNA) transcribed from a gene may be selectively processed to regulate which RNAs reach the cytoplasm to become messenger RNAs (mRNAs),
- (3) mRNAs may be selectively translated, and
- (4) proteins made from the mRNAs may be differentially modified.

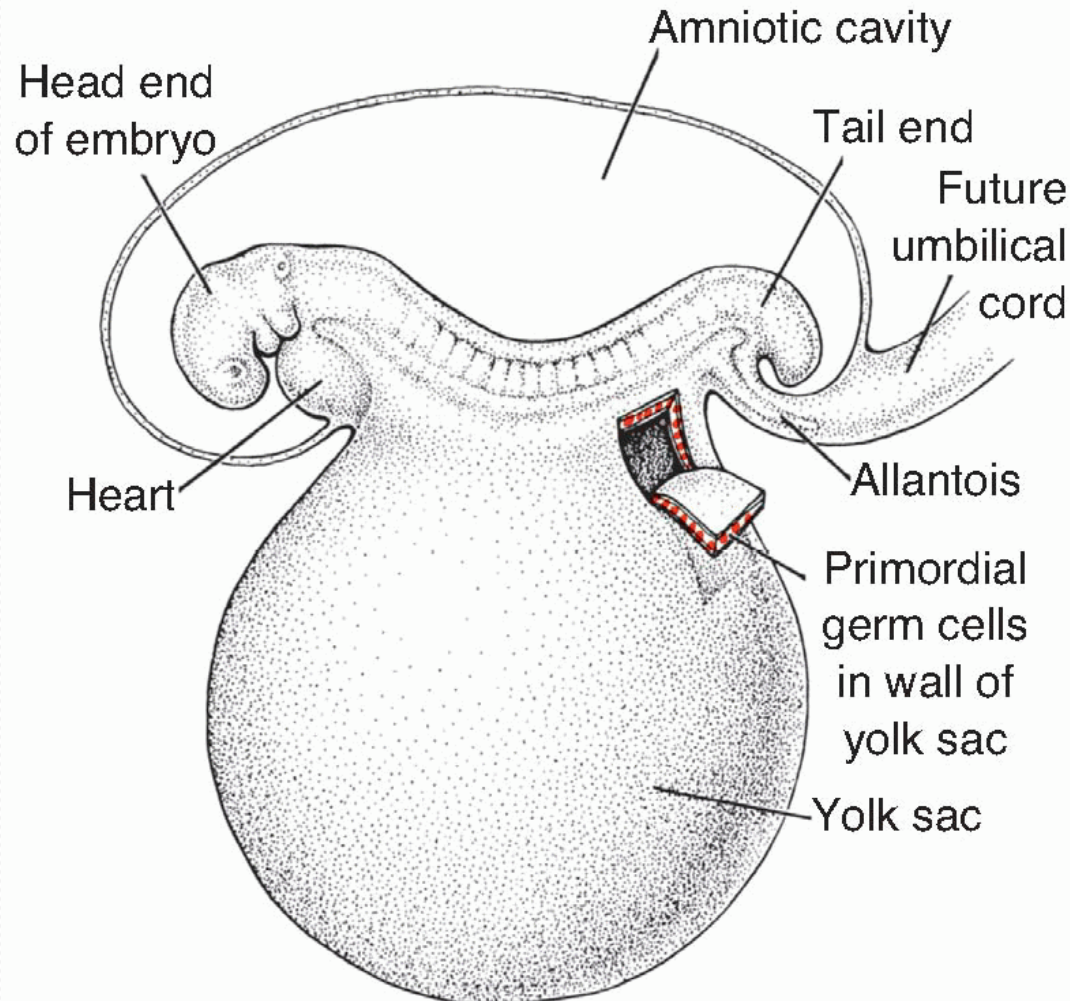
GAMETOGENESIS:

- Development begins with fertilization, the process by which the male gamete, the **sperm**, and the female gamete, the **oocyte**, **unite to give rise to a zygote**.
- Conversion of Germ Cells into Male and Female Gametes
- Sperm + oocyte = ➔ zygote

GAMETOGENESIS:

- Germ cells are derived from **primordial germ cells (PGCs)** that are formed in the **epiblast** during the **2nd week** of development that move to the wall of the yolk sac
- At the end of **3rd week** can be seen in the dorsal wall of the yolk
- **4th week** they migrate toward the developing gonads
- **5th week** reaching them Mitotic divisions increase their number during their migration and also when they arrive in the gonad

- The germ cells undergo mitosis and germ cells undergo **gametogenesis**, which includes meiosis, to reduce the number of chromosomes and
- **cytodifferentiation to complete their maturation**



Clinical Correlates

- PGCs and Teratomas:maens Tumors contain a variety of tissues, such as bone, hair, muscle, gut epithelia, and others
- *Theories of development:*
 1. May arise from pluripotent stem cells that can differentiate into any of the three germ layers or their derivatives
 - 2.Or from PGCs that have stray from their normal migratory paths.
 - 3.Or from epiblast cells that give Another source is epiblast cells migrating through the primitive streak during gastrulation



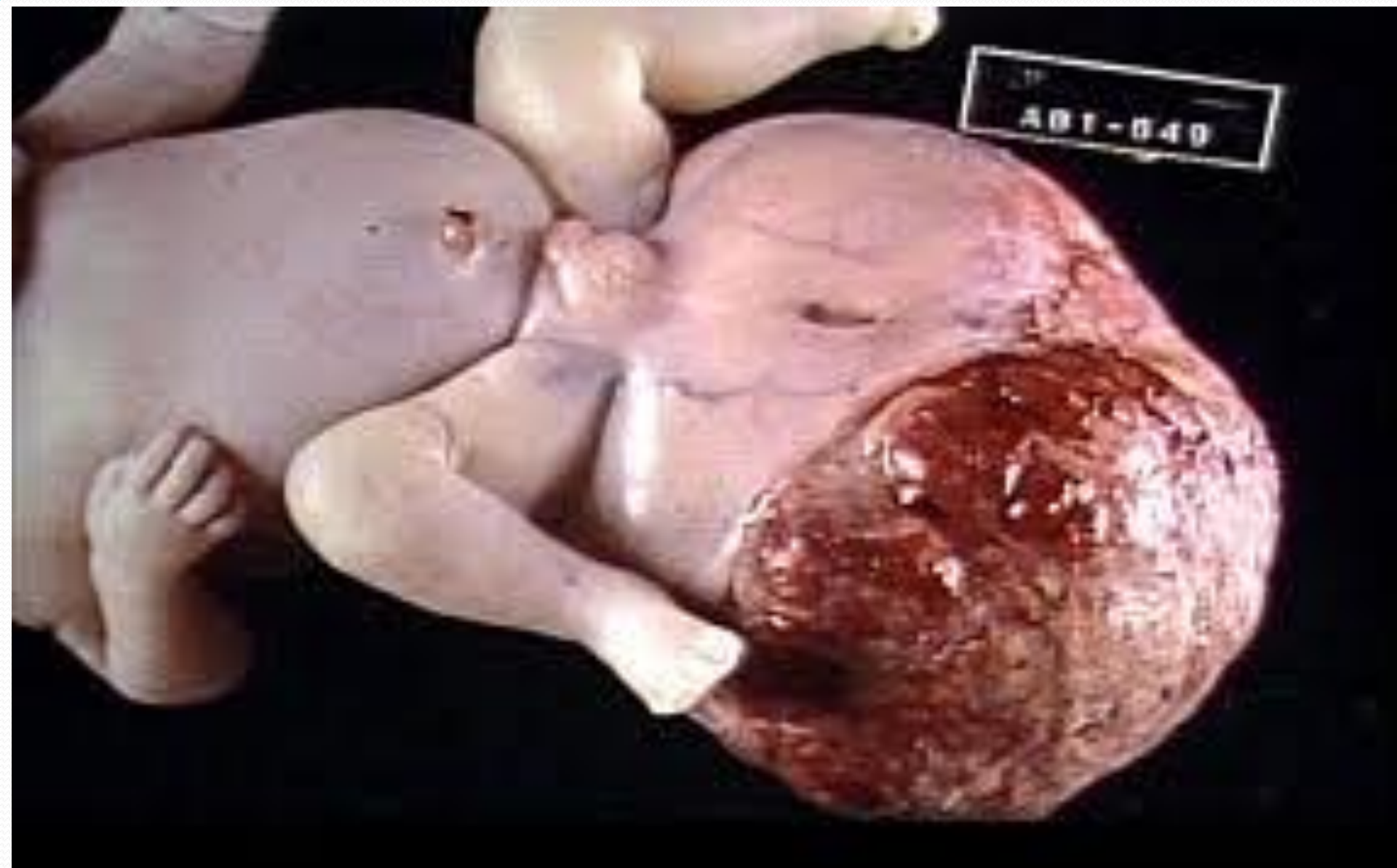


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The Chromosome Theory of Inheritance

The Chromosome Theory of Inheritance

- Traits of a new individual are determined by specific genes on chromosomes inherited from the father and the mother.
- Humans have approximately 35,000 genes on 46 chromosomes. Genes on the same chromosome tend to be inherited together and so are known as linked genes.
- In somatic cells, chromosomes appear as 23 **homologous pairs to form the diploid number of 46.**

The Chromosome Theory of Inheritance

- **There are 22 pairs of matching chromosomes, the autosomes, and one pair of sex chromosomes.**
- **If the sex pair is XX, the individual is genetically female; if the pair is XY, the individual is genetically male.**
- **One chromosome of each pair is derived from the maternal gamete, the oocyte, and one from the paternal gamete, the sperm.**
- **Thus each gamete contains a haploid number of 23 chromosomes, and the union of the gametes at fertilization restores the diploid number of 46.**

The CHROMOSOMES

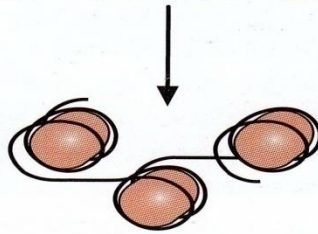
- Each chromosome (chromatin) is made up of fine filaments that are composed of DNA chain bound to basic proteins (mainly histone)
- The basic unit is the nucleosome (histone + 140 base pairs of DNA).
- Heterochromatin: inactive state the chromatin appear as beads of nucleosomes on a string of DNA.
- Euchromatin: active state, the DNA uncoiled from the beads.

The CHROMOSOMES

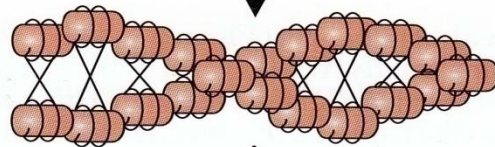
- The humans have about 35,000 genes on 46 chromosomes.
- Somatic cell made up of 46 chromosomes representing 23 homologous pairs of chromosomes
- 22 pair ==> autosomes
- 1 pair ==> sex chromosome



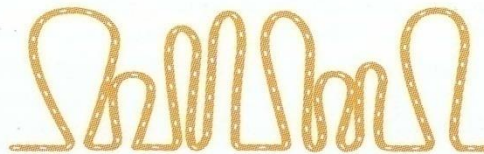
2 nm



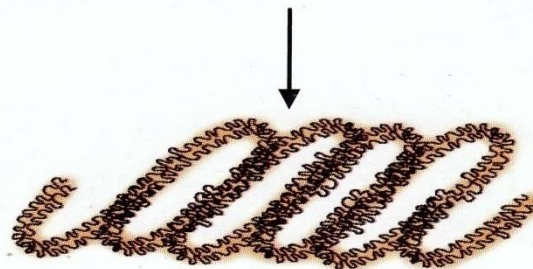
11 nm



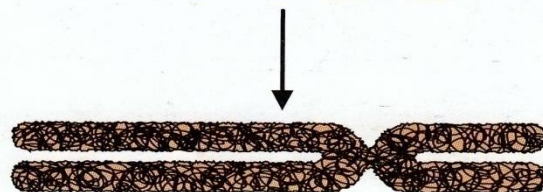
30 nm



300 nm



700 nm



1400 nm

Mitosis

- one cell divides, giving rise to two daughter cells that are genetically identical to the parent cell
- 1. The prophase;
 - The 46 chr. were replicating their DNA contents (from N to 2N). each chromosome replicates its deoxyribonucleic acid (DNA
 - chromosomes are extremely long, they are spread diffusely through the nucleus, and they cannot be recognized with the light microscope
 - With the onset of mitosis, the chromosomes begin to coil, contract, and condense; these events mark the beginning of prophaseThe *prophase* is marked by beginning of the chr. to be **coiled, condensed and contract.**

Mitosis

- 2. The prometaphase:

- Each of the contracted *chr* could be seen as *two parallel units connected by a centromere*, each unit is called a chromatid.
- Each chromatid contains DNA amount (N) of a normal chr before mitosis (thus it is structurally a chromosome).
- Such chromosomes could be called as a doubled structure chr.
- The *nuclear membrane* is *degenerating* during this phase.

Mitosis

- 3. The metaphase:
 - the doubled structured chr are arranged in equator of the cell,
 - they are attached by the microtubules of the mitotic spindle that extend from the centromeres to the centroiles lying at the opposite poles of the cell.

Mitosis

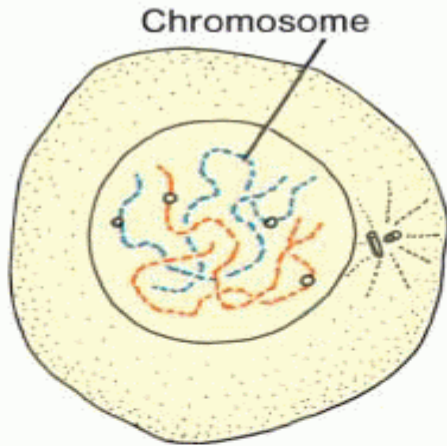
- 4. The anaphase:

- The centromeres are splitted resulting in separation of the chromatids
- They migrate toward the opposite poles of the cells by the contraction of the microtubules of the spindle.

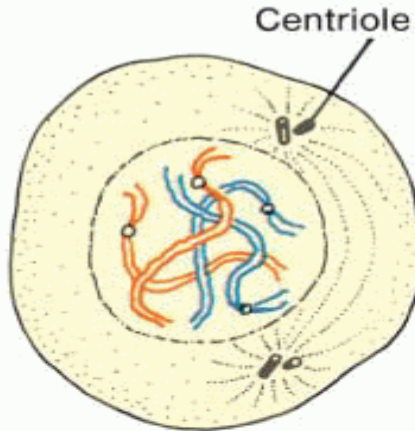
Mitosis

- 5. The telophase:
 - The chr uncoiled and diffused inside the reformed nuclear membrane,
 - The cytoplasm divides.
 - The daughter cells contain the same diploid 46 single structured chr number and the N amount of DNA as the mother cells.

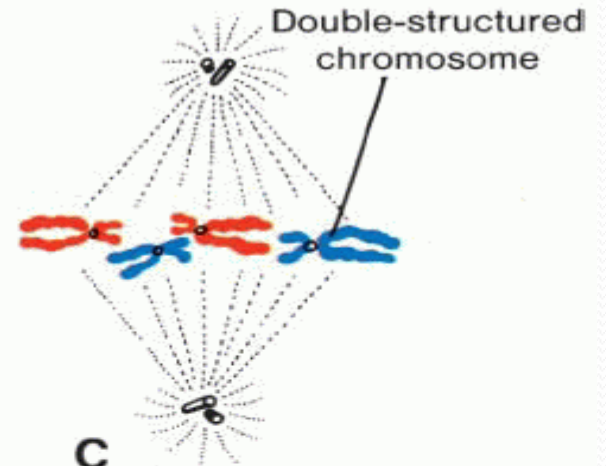
Mitosis



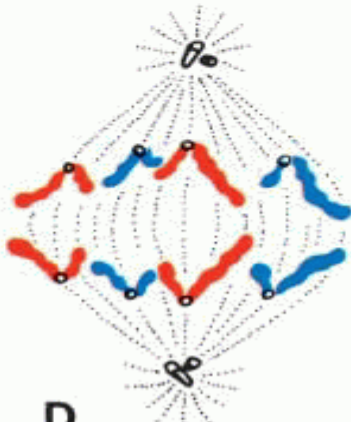
A
Prophase



B
Prometaphase



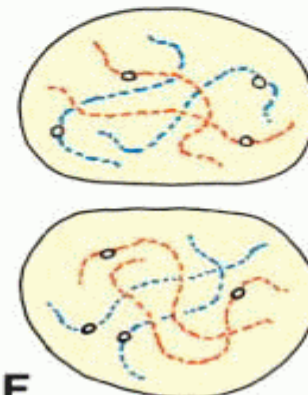
C
Metaphase



D
Anaphase



E
Telophase



F
Daughter cells



The End