GENERAL EMBRYOLOGY

Embryology = the study of the embryo (more generally = study of the prenatal devp .)

Embryo = when the intrauerus baby is between 2- 8 weeks (2 months)

Fetus = when the intrauerus baby is over 8 weeks old

Q:We are very concerned about the first 3 months of pregnancy ? (critical time)

A:Because during this time we have the head and neck **formation** - After 3 months the fetus is growing .

T/F embryology includes the study of the first 2- 8 weeks of pregnancy ? False

By day 0 (fertilization)

Ontogeny	Teratology
The stages of development of an individual (normal development)	**The abnormal development of an individual (congenital malformations) Ex : cleft lip and palate**

Mitosis	Meiosis
Somatic cells	Germ cells
In prophase : 2N , 4c	In prophase 1 : 2n , 4c
No crossing over	Crossing over occurs in prophase 1 when the chromosomes align and form a tetrad via chiasmas.
In anaphase , the chromosomes separate and the chromatids migrate to the opposite poles of the cell. (same as prophase 2 in meiosis)	In anaphase 1 the entire chromosome migrates to the opposite poles of the cell 2n , 2c
Final product is 2 cells each has 2n , 2c and they are identical to the mother cell .	In anaphase 2 the chromosomes separate and we get 4 cells each has 1n , 1c

NOTE: germ cells are not sex cells , they are cells that are similar to somatic cells

The reduction in the number of chromosomes in meiosis is due to first nuclear division then cytoplasmic division.

GAMETOGENISIS :

- The process of formation and development of male (sperm) and female (ovum) gametes .
- Includes the reduction of the # of chromosomes from diploid (46) in primary germ cells to haploid (23) in mature germ cells .
- Involves chromosomal and cytoplasmic changes
- The alteration in the shape allows the germ cells to be ready for fertilization.

Gametogenesis :

Male germ cell	Female germ cell
The large rounded primary male germ cell loses most of it's cytoplasm and develops a head (which contains the nucleus + acrosomes for enzyme secretion) + neck (contains the mitochondria to provide energy to assist in movement + microtubules) + tail .	The rounded primary female germ cells become larger as a result of increase in the amount of cytoplasm and becomes an ovum.

- **Fertilization :** when a sperm contacts and ovum to form a **zygote** in the uterine tube .
- During fertilization only **one sperm** can penetrate the thick wall of the oocyte
- A zygote (containing 46 chromosomes) rapidly divides by mitosis to form a mass of cells as 2, 4, ,8,16 , 32 ..
- **A Morella** has (32 cells) – **(until now no differentiation , all cells are the same)**
- This mass of cells will continue to divide in order to give the different tissues then organs of the human body .
  Fertilization → formation of zygote → undergoes mitotic division → Morula

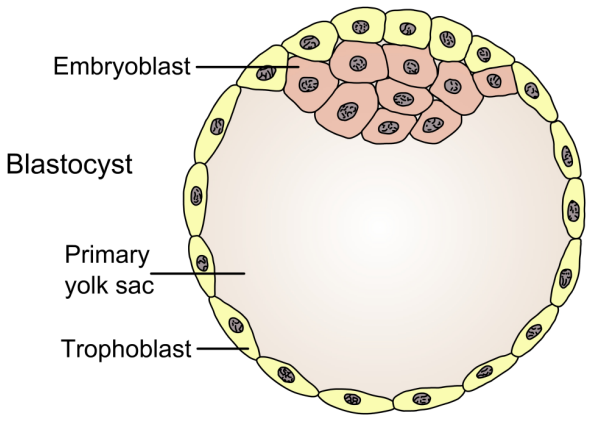
Q: what is the relationship between genotype / phenotype / environment ?

A: The expression of a **genotype** is affected by **environment** and the final outcome is termed **phenotype .**

EX: recessive alleles are sometimes not expressed in good environments .

Implantation in the uterine wall : happens after a week (7 days) it is not the morula that will be implanted it is the blastocyst /blastula / balstocyte.

After formation of a blastocyst the cells now will begin differentiation. **(the differentiation process has 3 steps) / general rule of differentiation:**



1- **Induction :** (activation) by cytokines – EX: Homeobox gene + growth hormones are inducers
2- **competence :** the cell must be competent by having the **corresponding receptors- other wise the inducers won't be able to activate the cell**
3- **Differentiation :** formation of 2 layers of cells (outer & inner cells)
   A. Embryoblasts → gives embryo
   B. Trophoblast → gives the placenta (imp for nutrition)
      *in between there in the primary yolk sac which comes from the mother

Cytokines: are hormones that **are not** produced directly into the blood , but they are produced into the neighboring cells .

- paracrine → cells producing cytokines acting on neighboring cells
- autocrine → cells producing cytokines acting on itself

STEPS of formation of a fetus :

1- **Formation of the 3 layered embryo :** (morula → blastocyst → bilaminar embryonic disk → trilaminar germ disk)
2- **Formation of neural crest cells**
3- **Folding of the embryo**

A. Formation of the 3 layered embryo :

WEEK 1 after fertilization	WEEK 2 after fertilization	Week 3 after fertilization
After a blastocyst is formed The trophoblast cells secrete enzymes to digest the endometrium (lining of the uterus) to allow implantation .	Formation of the 2 layered embryo : (bilaminar embryonic disk)- The blastocyst is inside the uterine wall + Formation of the (bilaminar embryonic disk) which will divide the primary yolk sac into amniotic cavity (upper) and secondary yolk sac (lower).	formation of the primitive streak at the midline causing the disc to have right and left halves (each half is a mirror to the other) then Gastrulation : Formation of the 3 layered embryo (trilaminar embryonic disc)

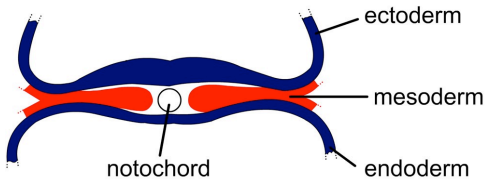
NOTE : the bilaminar embryonic disk (which comes from the embryoblast) will gives us all the organs (except the organs that come from the mesoderm)

Epiblast	Hypoblast
Cells above the bilaminar embryonic disc	Cells below the bilaminar embryonic disc
Columnar cells	Cuboidal cells
Will give ectoderm in 3rd week	Will give endoderm in 3rd week

- The primitive streak is responsible for the right and left sides of out body .

Endoderm	Mesoderm	Ectoderm
Formed by the hypoblast cells	Formed by the movement of epiblast cells that migrated into the hypoblast cells at the primitive streak	Formed by the epiblast cells

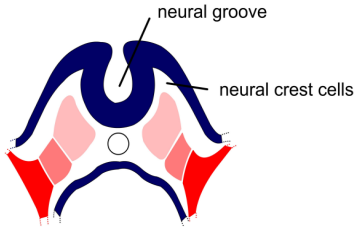
B. Formation of neural crest cells :



The notochord (a primitive structure that later degenerates and is replaced) is found between the ectoderm and the endoderm – it supports the embryo .

The **nervous system** develops as **a thickening within the ectoderm** giving the **neural plate** .

The **neural plate** will fold to form the **neural groove** → **neural groove** fuses to form the **neural tube** → **neural tube** gives rise to **brain & spinal cord**



Neurolation (during week 3) : formation of the neural tube

- The nervous system is the first system that develops in the human body .
- **The neural groove forms since the neural plate continues to grow but it is fixed on both sides .**

Formation of Ectomesoderm (4th layer) : The neural crest cells are cells found on the tip of the neural plate

when the neural tube forms , the tip cells will migrate into the underneath layer (mesoderm) to form the 4th layer .

Ectomesoderm : originates from ectoderm but has the function of mesoderm

Importance of ectomesoderm : it gives rise t the CT of the face and the CT of the teeth (dentin , cementum , alveolar bone etc ..) **while enamel comes from ectoderm .**

Neural crest cells migrate throughout the body and give rise to:

a. **Cranial and sensory ganglia and nerves**
b. Sympathetic neurones
c. Schwann cells
d. Pigment cells (melanocytes)
e. Meninges
f. **Cartilage** of branchial arches
g. Most of the connective tissue of the face “ectomesenchyme”
h. All tissues of a tooth and it’s supporting structures (alveolar bone , cementum , dentin , Pulp, PDL) **EXCEPT ENAMEL**

How is the neural crest formed ?

Formation of primitive streak → Thickening of the ectoderm → folding of the thickened ectoderm layer → neural groove → neural tube (will give brain + spinal cord) → migration of the cells at the tip of the neural plate will migrate from ectoderm to the CT underneath it and form the neural crest (which will later give ectomesenchymal cells)

NOTE : neural crest is essential in devp. of face + neck + oral tissue

Ectomenchymal cells = ectomesoderm layer

What will happen if neural crest cells fail to migrate to the CT underneath the ectoderm ?

A neural crest defect – **Treacher Collins syndrome** (mandibulofacial dystosis) **// almost no cartilage of the face , teeth supporting structures will not develop //**

Signs :

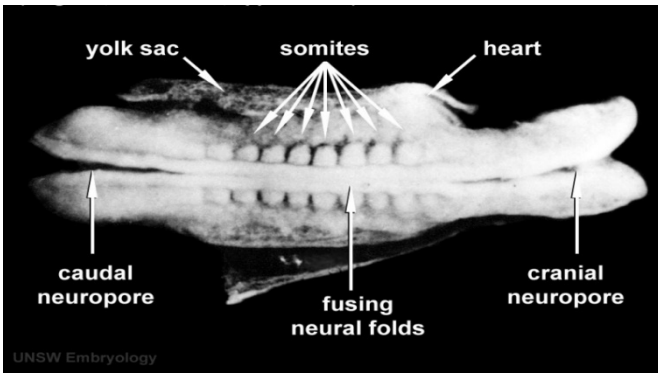
- underdevelopment of zygomatic bones
- Small mandible
- Malformed ears

DEVELOPMENT OF THE NERVOUS SYSTEM :

Ectoderm → neural plate →neural groove → neural tube → CNS (brain + spinal cord)

Brain = Forebrain + Midbrain + Hindbrain

DEVELOPMENT OF SOMITES :



Neuropore : an area that is not fused

- Caudal neuropore = tail
- Cranial neuropore = head

Heart is called the **foregut.**

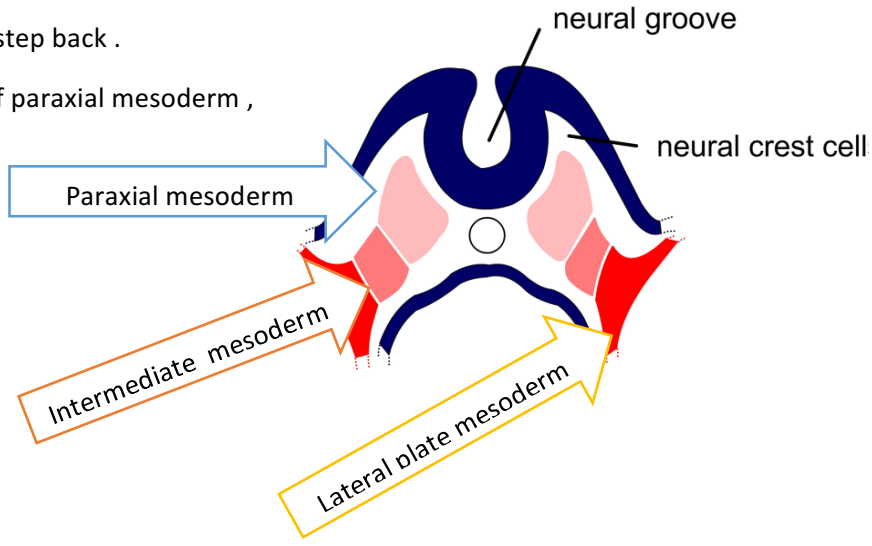
Neural folds: will become the spinal cord , around it we have the somites that will later give the (vertebra + muscles + skin of the back)

Mesoderm thickens on each side of midline to form **paraxial mesoderm .(along embryo's trunk paraxial mesoderm break into segmented blocks = somites , in the head it will form segements called somatomeres)**

- **Neural crest forms before ectmesoderm .**
- **Neural crest forms before the formation of neural tube .**

NOTE : When asked about origin you go one step back .

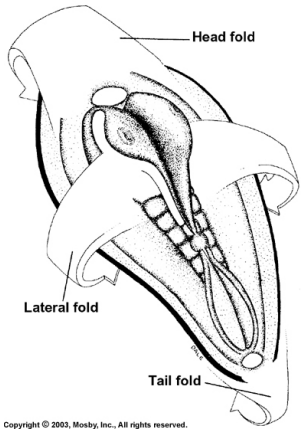
Intermediate mesoderm : at the periphery of paraxial mesoderm , mesoderm remains as a thin layer



MESODERM
(what each part will give rise to)

Paraxial mesoderm	Intermediate mesoderm	Lateral plate mesoderm
In the back region it will break into somites Each somite has 3 compartments : • Sclerotome : 2 adjacent vertebra + their disc . • Myotome : segmented mass of muscles • Dermatome : CT of skin overlying the somite In the head region the mesoderm partially segmented to form somatomeres, somatomeres form the muscles of the head	Urogenital sys	1- CT associated with the muscles and viscera (serous membrane of the pleura , pericardium , peritoneum) 2- Blood + lymph 3- Cardiovascular sys + lymphatic system 4- Spleen + adrenal cortex

FOLDING OF THE EMBRYO :



The embryo folds in 2 planes : (at the same time)

1- Along the longitudinal axis → to form the primitive oral cavity (stomodeum)
2- Along the lateral axis → To form the foregut

Q:When is the embryonic period complete ? at 8 weeks

- During week 3 the buccopharyngeal membrane separates between the foregut and the primitive oral cavity , it ruptures in week 4 to connect the stomodeum with the foregut.

Probable Question : what are the derivatives of each embryonic layer ?

Specific tissues given by each embryonic germ layer

Ectoderm	Mesoderm	Ecto-mesoderm	Endoderm
1- Tooth enamel 2- Intra – oral glands 3- Nervous sys. 4- Mammary & cutaneous glands 5- Epidermis , hair & nails 6- Sensory epithelium of the eye , ear , nose 7- Epithelium of sinuses , oral & nasal cavities.	1- Muscles 2- Bone 3- Cartilage 4- CT	1- Alveolar bone 2- Pulp 3- Dentin 4- Cementum 5- PDL	GIT epithelium + associated glands

NOTE : during the embryonic period the organs are forming , but during the fetal period the organs are growing .

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