

## Embryology Learning Objectives for the Anato-Bee

Anato-Bee Learning Objectives were obtained from the American Association for Anatomy, Anatomical Curriculum Task Force, and adapted by the co-founders of the Anato-Bee.

TOPIC	LOCAL OBJECTIVES	REGIONAL OBJECTIVES
<b>General Terminology</b>	Distinguish the difference between gestational age and fetal age/development.	Define “critical periods of development.”
	Define the three stages of fetal development (germinal, embryonic, and fetal).	
	Define the following terms in relation to embryology and human development: teratogen, organogenesis, primary germ layers, gametes, totipotent cells, pluripotent cells, and mesenchymal cells	Discuss the risks of harmful exposures (teratogens) to different tissues and organ systems using gestational age (first, second, and third trimesters).
<b>Gametogenesis</b>	Define meiosis and mitosis.	Describe the difference between structural and numerical chromosomal abnormalities.
	Compare the similarities and differences between meiosis and mitosis.	Discuss the birth defects involved with <b>numerical abnormalities</b> [down syndrome (trisomy), turner syndrome (monosomy), and Klinefelter syndrome (trisomy)].
	Define gametogenesis.	Discuss birth defects involved with <b>structural abnormalities</b> [Angelman and Prader-Willi syndrome (microdeletion) and cystic fibrosis (gene mutation)]
	Describe how mitosis and meiosis are involved in gametogenesis.	Define and explain the processes of spermatogenesis and oogenesis.
		Identify and label stages of spermatogenesis and oogenesis on a diagram.
<b>Fertilization and Implantation</b>	Define fertilization and identify where it typically occurs (within the uterine tube.	Describe the pre-implantation development sequence of: zygote --> morula --> blastocyst.
	Explain the genetic results of fertilization.	Discuss what occurs during an ectopic pregnancy.

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<b>Gastrulation</b>	Define gastrulation and its significance in embryonic development.	Describe the significance of the primitive pit/streak formation prior to gastrulation.
	Identify and label the three germ layers (ectoderm, endoderm, and mesoderm) on a diagram.	
	Using the three germ layers (ectoderm, endoderm, and mesoderm), discuss the role of gastrulation in forming tissues and organs.	Predict and discuss the developmental consequences if gastrulation does not occur properly. Use the following influences/conditions to better describe the consequences: teratoma, and birth defects associated with left-right sidedness.
<b>Neurulation</b>	Define neurulation.	Discuss the anatomic basis of various congenital anomalies of abnormal neural tube closure.
	Describe the formation of the neural plate and outline the steps in its transformation into a neural tube.	
	Define the origin and migration of neural crest cells.	
<b>Formation of Body Cavities</b>		Explain how the common embryonic body cavity becomes separated into pericardial, pleural, and abdominopelvic cavities.
<b>Musculoskeletal System</b>	Define somite and somitomeres and discuss their anatomical derivatives.	Describe somite formation and differentiation of somites into sclerotomes and dermomyotomes.
	Identify and give a brief explanation of the types of mesoderm cardiac and smooth muscle are derived from.	Describe the process of limb bud formation.

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<b>Cardiovascular System</b>	Describe the formation of the primary heart field including: <ul style="list-style-type: none"> <li>Defining primary and secondary heart fields</li> <li>Define the divisions of the heart tube and their anatomical derivatives.</li> </ul>	
	Describe the formation of the cardiac loop and septation of the heart (formation of the heart chambers).	Describe fetal circulation and the three vascular shunts involved (foramen ovale, ductus venosus, ductus arteriosus). Discuss the changes of these shunts after birth.
<b>Respiratory system</b>	Describe the development of the respiratory system from endodermal and mesodermal components.	Discuss the formation of the esophagus and trachea.
	Describe the five stages of lung maturation (embryonic, pseudoglandular, canalicular, saccular, alveolar).	Discuss the abnormalities that may occur with error in this development (e.g. esophageal atresia and tracheoesophageal fistulas).
		Discuss the importance of surfactant and the concern with premature infants born before 28- weeks gestational age.
<b>Gastrointestinal (GI) System</b>	List the organs derived from the foregut, midgut, and hindgut portions of the gut tube.	Explain the vascular and nerve supply of adult derivatives of each region of the gut tube.
<b>Urinary and Reproductive Systems</b>	Describe the development of the pronephros, mesonephros, and metanephros.	Identify when the kidney becomes functional and the process of urine and excretion of waste within the fetus.
<b>Urinary and Reproductive Systems</b>	Discuss the formation of gonadal ridges and genital ducts.	
	Discuss the development of genital ducts in the presence/absence of testosterone	Discuss the indifferent stage of external genitalia and what hormones drive the differentiation of external genitalia structures.

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Head and Neck	Define the terms pharyngeal arch, pharyngeal pouch, and pharyngeal groove.	List the skeletal components, muscle groups, nerves and arteries associated with each pharyngeal arch.
		Describe the structures in the adult that are derived from the pharyngeal pouches.