### **Formation of the Primitive Gut Tube**

**1. From which embryonic germ layer does the primitive gut tube originate?**

* Endoderm.

**2. What role does the yolk sac play in forming the primitive gut tube?**

* Provides nutrients and forms part of the gut tube during folding.

**3. How is the gut tube connected to the developing embryo's body wall?**

* Through the vitelline duct.

### **Regional Differentiation**

**1. Which regions of the gut tube form the foregut, midgut, and hindgut?**

* **Foregut**: Esophagus to the upper duodenum.
* **Midgut**: Lower duodenum to the proximal two-thirds of the transverse colon.
* **Hindgut**: Distal one-third of the transverse colon to the rectum.

**2. What structures arise from the foregut?**

* Esophagus, stomach, liver, pancreas, and upper duodenum.

**3. Which artery primarily supplies the midgut during development?**

* Superior mesenteric artery.

### **Formation of Major Structures**

**1. How does the esophagus elongate during development?**

* Through the growth and lengthening of the embryo's body.

**2. What process leads to the characteristic shape of the stomach?**

* Differential growth of the dorsal wall and rotation around its axis.

**3. How do the intestines achieve their final positioning within the abdomen?**

* By herniating into the umbilical cord and retracting during rotation.

### **Development of Accessory Organs**

**1. From which region of the gut tube does the liver develop?**

* Foregut.

**2. What is the role of the pancreatic buds in forming the pancreas?**

* The dorsal and ventral buds fuse to form the complete pancreas.

**3. How does the gallbladder develop, and what is its primary function?**

* Develops as a bud from the liver and stores bile.

### **Kidney Development**

**1. What are the three stages of kidney development?**

* Pronephros, mesonephros, and metanephros.

**2. Which stage of kidney development becomes the functional adult kidney?**

* Metanephros.

**3. What happens to the pronephros during development?**

* It regresses and is replaced by the mesonephros.

### **Formation of the Ureters**

**1. From which structure do the ureters develop?**

* Ureteric bud.

**2. How do the ureters connect to the bladder?**

* They attach to the posterior wall of the bladder.

**3. What is the role of the ureteric bud in kidney development?**

* Induces the formation of nephrons in the metanephros.

### **Bladder Development**

**1. From which embryonic structure does the bladder originate?**

* Cloaca.

**2. How is the cloaca divided during bladder development?**

* By the urorectal septum into the urogenital sinus and rectum.

**3. Which part of the bladder is derived from the mesonephric ducts?**

* The trigone.

### **Urethra Formation**

**1. How does the urethra differ in its development between males and females?**

* In males, it extends through the penis; in females, it ends near the vaginal opening.

**2. What role does the urogenital sinus play in urethral formation?**

* Forms the epithelium of the urethra.

**3. What developmental abnormality results if the urethra fails to close properly in males?**

* Hypospadias.

### **Gonadal Development: Differentiation of the Ovaries**

**1. What gene is primarily responsible for promoting ovarian differentiation in the absence of SRY?**

* WNT4 gene.

**2. At what embryonic stage do primordial germ cells migrate to the gonadal ridges to initiate ovarian development?**

* Weeks 5-6.

**3. How do the cells of the gonadal ridge contribute to ovarian differentiation?**

* Support primordial germ cells and form the ovarian follicles.

**4. Name the structure within the developing ovary that houses the oocytes during development.**

* Follicles.

### **Formation of the Müllerian Ducts**

**1. What hormonal factor prevents the degeneration of the Müllerian ducts in female embryos?**

* Absence of anti-Müllerian hormone (AMH).

**2. Describe the role of the Müllerian ducts in forming the fallopian tubes, uterus, and upper part of the vagina.**

* They differentiate and fuse to form these structures.

**3. During what weeks of gestation do the Müllerian ducts fuse to form the uterus?**

* Weeks 10-12.

**4. What congenital condition arises when the fusion of the Müllerian ducts is incomplete or fails?**

* Uterine anomalies, such as a bicornuate uterus.

### **External Genitalia Development in Females**

**1. What structure in the indifferent stage of genital development gives rise to the clitoris in females?**

* Genital tubercle.

**2. Describe how the urogenital folds and labioscrotal swellings develop into female external genitalia.**

* Urogenital folds form the labia minora, and labioscrotal swellings form the labia majora.

### **Gonadal Development: Differentiation of the Testes**

**1. What gene on the Y chromosome initiates testicular differentiation in males?**

* SRY (Sex-determining Region of Y).

**2. Name the cells in the developing testes that produce anti-Müllerian hormone (AMH) and their role in male reproductive development.**

* Sertoli cells produce AMH, which prevents the development of Müllerian ducts.

**3. How do Sertoli cells and Leydig cells contribute to the differentiation of the male gonads?**

* Sertoli cells: Support germ cells and produce AMH.
* Leydig cells: Produce testosterone, promoting the development of Wolffian ducts.

**4. During what stage of development does the gonadal ridge differentiate into the testes?**

* Week 6-7 of embryogenesis.

### **Formation of the Wolffian Ducts**

**1. What hormone promotes the development of the Wolffian ducts into the male reproductive tract, and what cells produce it?**

* Testosterone, produced by Leydig cells.

**2. Which structures in the male reproductive system are derived from the Wolffian ducts?**

* Epididymis, vas deferens, seminal vesicles, and ejaculatory ducts.

**3. What would occur if testosterone levels are insufficient during Wolffian duct development?**

* Incomplete development of male reproductive structures.

### **External Genitalia Development in Males**

**1. What embryonic structure gives rise to the penis during male genital development?**

* Genital tubercle.

**2. How does the fusion of the urogenital folds contribute to the formation of the male urethra?**

* The folds fuse along the midline, enclosing the urethral groove to form the penile urethra.

**3. What is hypospadias, and how is it related to errors in external genitalia development?**

* A condition where the urethra opens on the underside of the penis due to incomplete fusion of the urogenital folds.

### **Descent of the Testes**

**1. What is the purpose of the gubernaculum in the descent of the testes?**

* Guides the testes from the abdomen to the scrotum.

**2. Name one potential complication associated with incomplete descent of the testes (cryptorchidism).**

* Infertility or increased risk of testicular cancer.

### **Formation of the Lung Buds**

**1. From which embryonic structure do the lung buds originate, and during which week of development does this occur?**

* Foregut endoderm, during week 4.

**2. What signaling molecule plays a critical role in the initial formation of the lung buds from the foregut?**

* Fibroblast Growth Factor (FGF).

**3. How does the separation of the trachea and esophagus occur during development, and what anomaly results if this process is incomplete?**

* Formation of the tracheoesophageal septum separates them. Failure leads to tracheoesophageal fistula.

### **Branching Morphogenesis**

**1. What is branching morphogenesis, and why is it important in the development of the respiratory system?**

* The repeated branching of bronchi and bronchioles, forming the complex lung structure for efficient gas exchange.

**2. How do fibroblast growth factors (FGFs) contribute to the branching process of bronchi and bronchioles?**

* Stimulate epithelial cell proliferation and branching.

**3. What structural feature of the lungs results from repeated branching during morphogenesis?**

* A tree-like network of airways.

### **Alveolar Development**

**1. During which developmental stage do alveoli begin to form, and how does their structure change postnatally?**

* Begin forming in the saccular stage; mature and increase in number postnatally.

**2. Explain the role of type I and type II alveolar cells in lung function and alveolar maturation.**

* Type I: Gas exchange.
* Type II: Produce surfactant and repair alveoli.

### **Surfactant Production**

**1. What is surfactant, and which cells produce it in the lungs?**

* A substance that reduces surface tension, produced by type II alveolar cells.

**2. At approximately what gestational age does surfactant production begin, and why is it critical for neonatal survival?**

* Around 24-28 weeks, critical to prevent respiratory distress syndrome in preterm infants.

### **Pharyngeal Arches**

**1. How many pharyngeal arches form during embryonic development, and during which week do they appear?**

* Five arches (1, 2, 3, 4, 6), appearing in week 4.

**2. Name one skeletal structure and one cranial nerve derived from the first pharyngeal arch.**

* Skeletal: Mandible.
* Cranial Nerve: Trigeminal nerve (CN V).

**3. Which pharyngeal arch gives rise to the muscles of facial expression, and what nerve innervates them?**

* Second arch, innervated by the facial nerve (CN VII).

**4. What are the derivatives of the third pharyngeal arch?**

* Skeletal: Hyoid bone.
* Cranial Nerve: Glossopharyngeal nerve (CN IX).

### **Development of the Face**

**1. What embryonic prominences fuse to form the upper lip?**

* Maxillary and medial nasal prominences.

**2. Which embryonic structure forms the philtrum of the lip and the primary palate?**

* Intermaxillary segment.

**3. What congenital condition results from improper fusion of the maxillary and medial nasal prominences?**

* Cleft lip.

### **Formation of the Oral and Nasal Cavities**

**1. During development, how is the oral cavity separated from the nasal cavity, and what structure forms this separation?**

* The palate forms the separation.

**2. What developmental failure leads to a cleft palate?**

* Incomplete fusion of the palatal shelves.

### **Development of the Ear**

**1. From which embryonic structures do the three parts of the ear (inner, middle, and outer ear) originate?**

* Inner ear: Otic placode.
* Middle ear: First pharyngeal pouch.
* Outer ear: First pharyngeal cleft.

**2. How does the otic placode contribute to the formation of the inner ear?**

* Invaginates to form the otic vesicle, which develops into the cochlea and vestibular system.

**3. What structure derived from the first pharyngeal pouch contributes to the middle ear cavity?**

* Tympanic cavity and Eustachian tube.

### **Neurulation: Formation of the Neural Tube**

**1. What embryonic structure gives rise to the neural tube, and during which week of development does this process occur?**

* The neural plate, during week 3.

**2. Name two regions where the neural tube initially remains open before closing completely.**

* Cranial neuropore and caudal neuropore.

**3. What condition results from the failure of the neural tube to close at the cranial end?**

* Anencephaly.

### **Differentiation of the Neural Tube**

**1. What primary brain vesicles form from the cranial end of the neural tube?**

* Prosencephalon (forebrain), mesencephalon (midbrain), and rhombencephalon (hindbrain).

**2. Describe the role of the sulcus limitans in the differentiation of the neural tube.**

* Separates the dorsal (sensory) and ventral (motor) regions of the neural tube.

**3. What structure within the neural tube develops into the central canal of the spinal cord?**

* The lumen of the neural tube.

### **Neural Crest Cells**

**1. What is the origin of neural crest cells, and why are they considered pluripotent?**

* Origin: Ectoderm near the neural tube.
* Pluripotent because they give rise to diverse structures like peripheral nerves, facial cartilage, and pigment cells.

**2. Name three derivatives of neural crest cells.**

* Melanocytes, Schwann cells, and adrenal medulla.

**3. How does improper migration of neural crest cells lead to Hirschsprung disease?**

* Absence of neural crest-derived ganglion cells in the intestine causes bowel obstruction.

### **Formation of the Peripheral Nervous System**

**1. Which part of the neural tube gives rise to motor neurons, and how are sensory neurons formed?**

* Ventral neural tube gives rise to motor neurons.
* Sensory neurons form from neural crest cells.

**2. What embryonic structures develop into the dorsal root ganglia?**

* Neural crest cells.

**3. How do Schwann cells, derived from neural crest cells, contribute to peripheral nerve function?**

* They form the myelin sheath around peripheral nerves.

### **Teratology**

#### **Definition and Causes**

**1. Define teratology and explain its significance in developmental biology.**

* The study of birth defects caused by abnormal development.
* Significant for understanding and preventing congenital anomalies.

**2. Name three categories of teratogenic factors and provide an example of each.**

* **Chemical**: Alcohol (causes fetal alcohol syndrome).
* **Infectious**: Rubella virus (causes congenital rubella syndrome).
* **Physical**: Radiation (causes microcephaly).

#### **Critical Periods of Development**

**1. Why are the first trimester and embryonic period critical for the prevention of teratogenic effects?**

* Major organ systems develop during this period, making them highly susceptible to damage.

**2. Give an example of a teratogen and describe the defect it causes if exposure occurs during this period.**

* Thalidomide: Causes limb deformities when taken during early pregnancy.

#### **Prevention and Management**

**1. Name two strategies that can reduce the risk of teratogenic effects during pregnancy.**

* Avoid exposure to known teratogens.
* Take prenatal vitamins, especially folic acid.

**2. What role does folic acid play in preventing neural tube defects?**

* Folic acid is essential for DNA synthesis and cell division, reducing the risk of neural tube defects like spina bifida.