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# Goals and outcomes – Gametogenesis, fertilization (Embryology chapter 1)

**Be able to:**

- **Define and use:** progenesis, gametogenesis, primordial gonocytes, spermatogonia, primary and secondary spermatocytes, spermatids, sperm cells (spermatozoa), oogonia, primary and secondary oocytes, polar bodies, ovarian follicles (primordial, primary, secondary, tertiary), membrane granulosa, cumulus oophorus, follicular antrum, theca folliculi interna and externa, zona pellucida, corona radiata, ovulation, corpus luteum, corpus albicans, follicular atresia, expanded cumulus, luteinizing hormone (LH), follicle-stimulating hormone (FSH), human chorionic gonadotropin (hCG), sperm capacitation, acrosome reaction, cortical reaction and zona reaction, fertilization, zygote, cleavage, implantation, gastrulation, organogenesis, embryo, fetus, cell division, differentiation, morphogenesis, condensation, migration, delamination, apoptosis, induction, genotype, phenotype, epigenetics, ART – assisted reproductive techniques, spermiogram, IVF-ET (in vitro fertilization followed by embryo transfer), GIFT – gamete intrafallopian transfer, ICSI – intracytoplasmatic sperm injection
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Give** examples of epigenetic mechanisms (at least three of them) and **explain** how these may affect the formation of phenotype.
- **Give** examples of ethical issues in embryology (at least three of them).
- **Explain** how the sperm cells are formed, starting with primordial gonocytes. Compare the nuclear DNA content, numbers of chromosomes, cell shape and size in all stages.
- **Explain** how the Sertoli cells and Leydig cells contribute to spermatogenesis.
- **List** the parameters used for sperm analysis. What are their normal values?
- **Explain** how the mature oocytes differentiate, starting with oogonia.
- **Explain** how the LH and FSH contribute to oogenesis.
- **Compare** the timing of meiosis during spermiogenesis and oogenesis.
- **Compare** the main mechanisms of morphogenesis in epithelial embryonic structures vs. mesenchymal structures. Give examples of two organs where both epithelial and mesenchymal components take part in the organogenesis.
- **Compare** the endocrine vs. paracrine vs. autocrine transport of signal molecules.
- **Compare** the developmental processes during progenesis vs. embryogenesis vs. fetal period of prenatal development.
- **Explain** how the sperm penetrates through barriers surrounding the oocyte. **Name** the anatomical parts of female reproductive system where fertilization usually occurs.
- **Explain** the maternal inheritance of mitochondrial DNA.
- **Explain** how could be fertilized oocytes differentiated from unfertilized oocytes using optical microscope.
- **Predict** how the fertilization would be affected if the sperm capacitation would have failed.
- **Predict** what could happen if the cortical reaction and zona reaction would not happen.

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# Goals and outcomes – Blastogenesis, implantation, gastrulation, notochord, mesoderm, somites (Embryology chapter 2)

**Be able to:**

- **Define and use:** cleavage, blastomeres, morula, hatching, blastocoelom, blastocyst, trophoblast, embryoblast, epiblast, hypoblast, gastrulation, implantation (nidation), syncytiotrophoblast, cytotrophoblast, abnormal implantation, extrauterine pregnancy, extraembryonic coelom, extraembryonic mesoderm (splanchnopleuric and somatopleuric), amniotic vesicle, yolk vesicle, bilaminar embryonic disc, ectoderm, endoderm, chorion, amnion, connecting stalk, trilaminar gastrula, mesoderm, primitive streak, primitive (Hensen's) node, primitive pit, prechordal plate, cloacal plate, allantois, chordomesodermal canal, notochordal process, notochordal canal (of Lieberkühn), neurenteric canal, notochord, neural tube, primitive gut, situs viscerum inversus, paraxial mesoderm, intermediate mesoderm, pronephros, mesonephros, metanephros, lateral plate mesoderm (somatopleuric and splanchnopleuric mesoderm), intraembryonic coelom, serous body cavities, oropharyngeal and cloacal membranes, somites, segmentation, dermatome, sclerotome, myotome
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Explain** how the diploid number of chromosomes is restored upon fertilization.
- **Explain** how the chromosomal sex is determined in human embryos.
- **Describe** the timing of mitoses and numbers of blastomeres during the first three days.
- **Compare** the morula with the blastocyst.
- **Compare** the origin and further differentiation of trophoblast and embryoblast.
- **Explain** how and when the blastocyst implants into the endometrium. What is the role of syncytiotrophoblast in this process?
- **Explain** how the yolk sac and amniotic sac are formed. What are the layers of bilaminar embryonic disc?
- **List** the layers of chorion and amnion.
- **Explain** how the bilaminar embryonic disc is transformed into trilaminar gastrula.
- **Name** at least three organs or tissues derived from ectoderm, endoderm, and mesoderm.
- **Compare** the position of oropharyngeal and cloacal membrane.
- **Explain** how the notochord is formed. What are the remnants of notochord in adult human?
- **Explain** how the walls of the intraembryonic coelom are formed. **Name** the body cavities coelom differentiates into.
- **Compare** further differentiation of lateral plate mesoderm, intermediate mesoderm, and paraxial (somatic) mesoderm. Which organs and structures develop from these parts?
- **Desribe** how somites are formed. **Name** the three parts into which each somite splits.
- **Compare** further differentiation of dermatome, sclerotome, and myotome.
- **Predict** how the implantation and early embryonic development would be affected by a too thick zona pellucida and failed hatching.
- **Predict** which developmental defect may result from a failed establishment of right-to-left axis at the stage of primitive streak.
- **Predict** which complications may result from an abnormal implantation of an embryo.
- **Predict** which body organs or tissues might fail to develop if the somitic and intermediate mesoderm failed to form properly.

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# Goals and outcomes – Fetal membranes. Placenta and umbilical cord. Prenatal growth. Delivery. (Embryology chapter 3)

**Be able to:**

- **Define and use:** fetal membrane, amnion, amniotic epithelium, amniotic cavity, amniotic fluid, expansion of amnion, amniochorionic membrane, oligohydramnios, polyhydramnios, chorion, syncytiotrophoblast, cytotrophoblast, extraembryonic mesenchyme, chorionic villi, chorion laeve, chorion frondosum, allantois, urachus, connecting stalk, umbilical cord, umbilical arteries and veins, omphaloenteric duct, secondary yolk sac, vitelline blood vessels, Wharton's jelly, fetal portion and maternal portion of placenta, decidua, intervillous space, cotyledons, placental villi, anchoring and free villi, placenta barrier, hemochorial placenta, placenta praevia, abruption of placenta, placenta accreta, placenta increta, placenta duplex, placental insufficiency, Rh isoimmunization, erythroblastosis fetalis, anti-D-immunoglobulin, monozygotic twins, dizygotic twins, progenesis, embryonic period, fetal period, obstetrics ultrasonography, crown-rump length (CRL), crown-heel length (CHL), femur length (FL), humerus length (HL), biparietal diameter (BPD), abdominal circumference (AC), head circumrefence (HC), occipitofrontal diameter (OFD), estimating the gestational age, fetal position in utero, fetal lie (situs), fetal position, fetal attidude (habitus), fetal praesentation; stages of labor; anatomical changes in pregnant women
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Compare** the primary chorionic villi vs. secondary chorionic villi vs. tertiary chorionic villi.
- **Discuss** the functions of amniotic fluid.
- **Contrast** between oligohydramnios and polyhydramnios. **Describe** possible causes and clinical outcomes of these.
- **Describe** the development of the maternal and the fetal portion of the placenta.
- **Compare** the histological layers of the placenta barrier in 4 weeks vs. in 4 months.
- **Describe** the role of placental barrier in establishment of selective transplacental transport. **Give examples** of five substances that normally pass the placenta barrier.
- **Name** three hormones produced by the placenta.
- **Compare** the concentration and affinity to oxygen in fetal vs. adult hemoglobin.
- **Describe** various mechanisms of twinning in the human.
- **Name** at least five anatomical changes occurring in female body during pregnancy.
- **Name** at least three abnormalities of placenta. **Discuss** their possible clinical outcome.
- **Compare** the time span and the developmental processes during progenesis, embryonic period, and fetal period.
- **Compare** the gestational age based on the conception date vs. age based on the last menstrual period date.
- **List** at least three parameters that can be measured during prenatal obstetric ultrasonography and used for assessment of embryonic/fetal age.
- **Name** at least five signs of a mature newborn.
- **Explain** what happens during the three stages of labor.
- **Predict** the complications of placenta that invaded the myometrium.
- **Predict** the complications resulting from too long or too short umbilical cord.
- **Predict** the impact of Rh isoimmunization during pregnancy. How can complications be prevented?

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# Goals and outcomes - Development of nervous system (Embryology chapter 4)

*This chapter overlaps with Chapter 11 (Development of skull, head, and face)*

**Be able to:**

- **Define and use:** ectoderm, neuroectoderm, neural plate, neural groove, neural folds, neural tube, anterior and posterior neuropores, neural crest, brain vesicles, prosencephalon, mesencephalon, rhombencephalon, telencephalon, diencephalon, metencephalon, pons, cerebellum, myelencephalon, medulla oblongata, spinal cord, neuroblasts, glioblasts, ventral basal plate, dorsal alar plate, sulcus limitans, dural sac, brain ventricles, hemispheres, neocortex, neurohypophysis, optic vesicles, neural tube defects, anencephaly, spina bifida, holoprosencephaly, hydrocephalus, myelination, cranial nerves, cranial nerve sensory ganglia, otic placode, otocyst, membranaceous labyrinth, tympanic cavity, external ear and external auditory meatus, lens placode, pigment and neural layers of retina, photoreceptors, iris, sclera, cornea, hyaloid artery, optic nerve, microphtalmia
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Explain** how the neural tube is formed. Describe at least three steps of its origin.
- **List** all the brain vesicles in the cranial to caudal direction. Which parts of brain will these vesicles differentiate into?
- **Compare** the differentiation of neurons and glia cells.
- **Compare** the differentiation of the ventral basal plate and the dorsal alar plate of the neural tube. How are these parts linked to the motor and sensory functions?
- **Describe** the positional changes of the spinal cord relative to the vertebral column. To which vertebra does the spinal cord extend in newborns and in adults?
- **List** at least three developmental defects that involve the neural tube or meninges.
- **Name** the sensory cranial nerves that originate from ectodermal neural placodes and from the neural crest.
- **Explain** the origin, differentiation and migration of the neural crest.
- **Predict** which condition affecting the development of brain will result from a blocked circulation of the cerebrospinal fluid.
- **Predict** which developmental defects (at least three of them) may be caused by abnormal migration of neural crest cells.
- **Predict** what would happen if the anterior neuropore would fail to close properly.
- **Predict** what would happen if the division of the prosencephalon into two hemispheres would not occur.

 

# Goals and outcomes - Development of circulatory system. Embryonic and extraembryonic circulation. Aortic arches. Veins. (Embryology chapter 5)

*This chapter overlaps with Chapter 6 (Development of heart)*

**Be able to:**

- **Define and use:** vasculogenesis, angiogenesis, angioblasts, mesenchyme, blood islands, early bilateral circulation, heart tube, umbilical arteries, umbilical veins, vitelline arteries, vitelline veins, segmental arteries and veins, common cardinal vein, unified circulation, aortic arches (1st-6th), maxillary artery, hyoid and stapedial artery , common carotid artery, subclavian artery, aortic arch, ductus arteriosus, pulmonary arteries, intercostal arteries, lumbar arteries, common iliac arteries, renal and suprarenal arteries, testicular and ovarian arteries, medial umbilical ligaments, coeliac trunc, superior and interior mesenteric artery, subcardinal/sacrocardinal and supracardinal veins, lig. teres hepatis, ligmanetum venosum, hepatic liver sinusoids, ductus venosus, formaen ovale, left and right atrium, left and right ventricle, septum primum, septum secundum, coarctation of aorta (preductal and postductal), double aortic arch
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Compare** the vasculogenesis with angiogenesis.
- **Describe** the luminization of blood islands.
- **Explain** how the extraembryonic circulation is connected with intraembryonic circulation.
- **Name** the arteries and veins of the early bilateral circulation. What is the direction of blood flow in these vessels, i.e., which regions are supplied and drained by these vessels?
- **Name** the arteries and veins that become unified from the early bilateral circulation.
- **Explain** how the aortic arches (i.e., arteries of the pharyngeal arches) participate on formation of blood vessels of head, neck and thoracic region. Name the arteries persisting from embryonic aortic arches.
- **List** examples of derivatives of arteries branching from the descending aorta (at least two examples of derivatives of dorsal intersegmental or lateral segmental arteries).
- **Describe** the transport of oxygen and nutrients in embryonic and fetal circulation.
- **Explain** the major circulatory changes at birth affecting heart and major blood vessels.
- **Compare** the prenatal vs. postnatal blood circulation.
- **Explain** what happens after birth with umbilical arteries, umbilical vein, ductus venosus, and ductus arteriosus.
- **Compare** the preductal vs. postductal coarctation of aorta.
- **Predict** how the postnatal circulation could be affected by a persisting ductus arteriosus.
- **Predict** which developmental defect may result from persistence of both right and left fourth aortic arches.

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# Goals and outcomes - Development of heart. (Embryology chapter 6)

*This chapter overlaps with Chapter 5 (Development of circulatory system)*

**Be able to:**

- **Define and use:** angiogenesis and vasculogenesis, blood islands, heart tube, cardiac myoblasts, endocardium, myocardium, epicardium, heart loop, sinus venosus, common cardinal vein, umbilical vein, vitelline vein, atrioventricular canal, primitive ventricle, bulbus cordis, conus arteriosus, right atrium, left atrium, sinoatrial orifice, septum spurium, atrial septation, septum primum, foramen primum, foramen secundum, septum secundum, foramen ovale, endocardial cushions, septum intermedium, interventricular septum, bulbar ridges, truncus arteriosus, aorta, conducting system of the heart, atrial septal defects, persistent foramen ovale, persistent ductus arteriosus, coarctation of the aorta, ventricular septal defects, tetralogy of Fallot, transposition of great arteries
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Explain** how and when the heart tube is formed. When does the embryonic heart start to beat?
- **Name** three layers of the heart tube.
- **Explain** the anatomical changes during the formation of the heart loop.
- **Name** the veins that join the sinus venosus of the early embryonic heart. Which regions does each of these veins carry blood from?
- **Explain** the division of primitive atria into the left and right atrium. Which veins carry blood into each of these atria?
- **Compare** the circulation of blood in heart and in great vessels before birth and after birth.
- **Explain** how the primitive embryonic heart ventricle is divided into the right and the left ventricle. Name the parts of the interventricular septum. Explain the role of the bulbar ridges in separation of the major arteries.
- **List** the parts of the conducting system of the heart. **Explain**, how are they anatomically related to the heart atria and ventricles.
- **Name** the alterations present in the tetralogy of Fallot. Which of these develops to compensate the other alterations of this complex heart malformation?
- **Compare** two types of the coarctation of the aorta and their relation to the ductus arteriosus. What are the possibilities of collateral circulation to bypass the narrowing?
- **Explain** what happens after birth with the ductus arteriosus. How does the distribution of arterial and venous blood change after birth?
- **Predict** the consequences of the atrial septal defects upon blood circulation after birth.
- **Predict** what would happen after birth if the septum primum would be too small proportionally to the foramen ovale.
- **Predict** the consequences of the persistent ductus arteriosus upon blood circulation after birth.
- **Predict** the possible consequences of abnormal partitioning of the bulbus cordis, i.e., the abnormal development of the conotruncal region.

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# Goals and outcomes - Development of digestive system I. (Embryology chapter 7)

*This chapter overlaps with Chapter 8 (Development of digestive system II.)*

**Be able to:**

- **Define and use:** amniotic and yolk vesicle, ectoderm, endoderm, splanchnopleuric mesoderm, primitive gut, oral and cloacal membrane, foregut, midgut, hindgut, coeliac artery, superior and inferior mesenteric artery, ventral and dorsal mesentery, greater and lesser omentum, mesentery proper, mesocolon, coelom, stomodeum, oral cavity, pharynx, labial and dental lamina, labiogingival lamina and sulcus, dental buds, ameloblasts, enamel organ, dental papilla, odontoblasts, Tomes's fibres, enamel and dentin production, predentin, hydroxyapatite, cementoblasts, root sheath, eruption of teeth, Rathke's pouch, hypophysis, infundibulum of the diencephalon, pharyngeal (branchial) pouches 1-4, tubotympanic recess, tonsillar fossa, parathyroid glands, thymus, ultimobranchial body, pharyngeal clefts 1-4, external auditory meatus, auricular hillocks, cervical sinus, pharyngeal arches, nerves and arteries of pharyngeal arches, lung bud, tongue, tuberculum impar, lateral lingual swellings, copula, thyreoglossal duct, foramen caecum, tracheoesophageal septum, rotation of stomach
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Name** the three parts of primitive gut. What are the main arteries supplying these parts of gut?
- **Name** the nerves, muscles, arteries, and skeletal elements associated with pharyngeal arches 1, 2, 3, 4 and 6.
- **Explain** how the gut tube is connected to the body wall. Which structures develop within embryonic ventral and dorsal mesenteries?
- **Explain** how the stomodeum establishes an open communication with the pharynx.
- **Explain** the development of spatial relations between dental bud, enamel organ, and mesenchymal dental papilla. Which tissues are produced by these structures?
- **List** the cells that produce, enamel, dentin, and cementum.
- **List** muscles innervated by the nerves V., VII., IX., and X.
- **Explain** the dual origin of hypophysis from stomodeal epithelium and from the diencephalon.
- **Explain** the development of endodermal pharyngeal pouches and the origin of the auditory tube, tonsillar fossa, parathyroid glands and ultimobranchial body.
- **Explain** the development of the external ear.
- **Explain** the spatial and temporal development of the thyroid gland. Which remnant of the thyroglossal duct appears as a normal finding in some individuals? Which remnants are abnormal?
- **Explain** how the body and the radix of the tongue develop from different components.
- **Explain** why does the right vagus nerve form the posterior vagal trunk and the left vagus nerve forms the anterior vagal trunk?
- **Predict** which developmental defects may develop in case of incomplete closure of the cervical sinus?
- **Predict** what would happen if the derivatives of the endodermal pharyngeal pouches failed to develop?

 

# Goals and outcomes - Development of digestive system II and development of respiratory system. (Embryology chapter 8)

*This chapter overlaps with Chapter 7 (Development of digestive system I)*

**Be able to:**

- **Define and use:** foregut, midgut, hindgut, liver bud, liver cords, vitelline and umbilical veins, hepatic sinusoids, peritoneal membrane, rotation of duodenum, fetal hepatolienal hematopoiesis, dorsal and ventral pancreatic buds, endocrine pancreatic islets, annular pancreas, primary intestinal loop, vitelline duct, Meckel's diverticulum, physiological umbilical herniation, rotation of midgut, colon, mesenteries, greater and lesser omentum, caecum, appendix, cloaca, urorectal septum, urogenital sinus, anal canal, intraembryonic coelom, somatopleuric and splanchnopleuric mesoderm, pleural cavity, peritoneal cavity, diaphragm, septum transversum, pleuroperitoneal canals, spleen, dorsal mesogastrium, respiratory diverticulum, lung bud, bronchial buds, branching of bronchial tree, pseudoglandular period of lung development, canalicular period, terminal sac period, alveolar period, surfactant, onset of respiration after birth
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Explain** how the epithelial liver cords and hepatic sinusoids are formed
- **Name** hepatic structures that differentiate from the septum transversum.
- **Explain** the development of gall bladder and bile duct.
- **Explain** how the pancreas is formed from pancreatic buds. What is the developmental explanation of the presence of accessory pancreatic duct in some individuals?
- **Explain** how the pancreas reaches its final retroperitoneal position.
- **Describe** the rotation of the primary intestinal loop. Describe the rotation of the midgut loop during and after the period of physiological umbilical herniation.
- **Explain** how the cloaca is divided by the urorectal septum.
- **Describe** the embryonic origin of the pleural cavity, peritoneal cavity, and the diaphragm.
- **Explain** the development of spleen.
- **Explain** how the trachea is formed. Which structures develop when the bronchial buds keep on branching?
- **Compare** the stages in development and maturation of the lungs. At what age do the lungs reach the stage of mature alveoli?
- **Explain** why the lungs do not work properly in prematurely born babies?
- **Explain** the changes in the pulmonary circulation after the birth.
- **Explain** how the abnormal partitioning of the esophagus and trachea by the tracheoesophageal septum is linked with polyhydramnion.
- **Predict** which condition may result from abnormal rotation of the ventral pancreas.
- **Predict** which condition results from persistence of the vitelline duct.
- **Predict** what if the abdominal wall would close before the reposition of physiological umbilical hernia.
- **Predict** which condition results from a failure of formation of autonomic myenteric nervous plexus in the wall of colon.
- **Predict** what would happen if the tracheoesophageal septum would fail to develop properly?

 

## Goals and outcomes - Development of urinary system (Embryology chapter 9)

*This chapter overlaps with Chapter 10 (Development of genital system)*

**Be able to:**

- **Define and use:** coelom, intermediate mesoderm, nephrogenic cord, pronephros, mesonephros, mesonephric (Wolffian) duct, glomerulus, Bowman's capsule, nephron, proximal and distal tubules, collecting tubules, papillary ducts, efferent ductules, rete testis, metanephros, ureteric (metanephric) bud, metanephric mesoderm (blastema), ureter, renal pelvis, major and minor calyces, cloaca, hindgut, urorectal septum, urogenital sinus, anal canal, cloacal membrane, perineal body, allantois, urachus, median umbilical ligament, urethra, phallus, paramesonephric (Müllerian) ducts, renal dysplasia, accessory kidney, horseshoe kidney, pelvic kidney, congenital polycystic kidney disease, hypospadias, urachal fistula
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Compare** the anatomical position, timing of development, inner histological structure and function of pronephros, mesonephros, and metanephros.
- **Name** structures that develop from the ureteric bud and structures that develop from the metanephric blastema.
- **Name** the parts of nephron.
- **List** structures that develop from the mesonephric duct in male and in female.
- **Describe** the developmental interactions between the branching ureteric bud and the metanephric blastema.
- **Explain** the relations between mesonephric tubules and the mesonephric (Wolffian) duct.
- **Compare** the initial and the final anatomical positions of kidney.
- **Explain** how the cloaca gives rise to the urogenital sinus and the rectum.
- **Name** the organs that develop from the urogenital sinus in male and female embryos.
- **Explain** how the urinary bladder develops.
- **Explain** what happens with the allantois during human development. **H**ow does the urachal fistula originate?
- **Explain** the difference between developmental dystopia of kidney and a condition named renal ptosis (floating kidney).
- **Name** three congenital disorders of kidney resulting from abnormal fusion, division, or rotation of the embryonic metanephric blastema.
- **Predict** which developmental defects might cause an oligohydramnion.
- **Predict** which developmental defect may result from a failed junction between nephrons and collecting ducts.
- **Predict** what would happen if the ureteric bud would be branching too early.
- **Predict** what if the urachus would fail to obliterate.

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# Goals and outcomes - Development of genital system (Embryology chapter 10)

*This chapter overlaps with Chapter 9 (Development of urinary system)*

**Be able to:**

- **Define and use:** coelom, mesoderm, genital (gonadal) ridge, gonad, primordial gonocytes, indifferent stage, sexual dimorphism, mesonephric (Wolffian) duct, paramesonephric (Müllerian) duct, SRY gene, primitive sex cords, testis, ovary, cortical and medullary cords, tunica albuginea, spermatogonia, Sertoli cells, Leydig cells, anti-Müllerian hormone, seminiferous tubules, rete testis, androgens, mesonephric ducts, epididymis, efferent ductules, paradidymis and appendix of the epididymis, epididymic duct, ductus deferens, ejaculatory duct, ovarian follicle, oogonia, uterine tube, uterus, vagina, epoophoron and paroophoron, cloaca, genital tubercle, urorectal septum, cloacal membrane, perineum, urethral folds, outer genital swellings, urogenital sinus, urogenital groove, sinovaginal bulbs, vestibule of vagina, hymen, penile urethra, prepuce, scrotum, penis, clitoris, minor and major labia, descent of testis and of ovaries, inguinal canal, gubernaculum, cryptorchidism, inborn indirect inguinal hernia, hypogonadism, male and female pseudohermaphroditism, gonadotropins
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Explain** how the gonocytes reach their final position in gonads. What is the importance of the gonocytes for further differentiation of the gonads?
- **Compare** the development of the mesonephric (Wolffian) ducts in male and female embryos and fetuses. Name the structures developing from these ducts in male and in female.
- **Compare** the development of the paramesonephric (Müllerian) ducts in male and female embryos and fetuses. Name the structures developing from these ducts in male and in female.
- **Compare** the development of the genital tubercle, urethral folds, and the outer genital swellings in male vs. in female fetuses.
- **Explain** how the histological structures of testis and the structure of ovary differentiate from the indifferent stage of gonads.
- **Explain** the role of SRY gene, Sertoli cells, Leydig cells, and follicular cells in development of sexual dimorphism during prenatal development and during puberty. **Predict** the effects if any of these roles failed to be performed.
- **Explain** how the vagina is formed.
- **Describe** the developmental anatomy of cloaca.
- **Explain** how the testis and ovaries reach their final anatomical positions.
- **Predict** which developmental defects might result from a lack of fusion of the paramesonephric ducts.
- **Predict** which complications or medical conditions might result from a persisting vaginal process of the peritoneal membrane.
- **Predict** the effects of incomplete fusion of urethral folds in male.

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# Goals and outcomes - Development of head, skull, face, and palate (Embryology chapter 11)

*This chapter overlaps with Chapter 4 (Nervous system) and Chapter 7 (Development of digestive system). Understanding the development of the brain, sensory organs, pharyngeal arches, stomodeum, teeth, tongue, thyroid gland are prerequisites for the present chapter.*

**Be able to:**

- **Define and use:** somitic paraxial mesoderm, sclerotome, somatopleuric lateral plate mesoderm, neural crest, head ectomesenchyme, desmogenous (intramembranous) ossification, chondrogenous ossification, neurocranium, chondrocranium, desmocranium, viscerocranium, base of the skull, parachordal cartilages, hypophyseal cartilages, prechordal trabecular cartilages, frontonasal prominence, maxillary prominence, medial and lateral nasal prominence, lens placode, olfactory placode, otic placode, primary and secondary palate, intermaxilla, incisive foramen, philtrum, choanae, paranasal sinuses, sutures and fontanelles, bitemporal and biparietal diameter, fronto-occipital circumference, anencephaly, meningocele, meningoencephalocele, craniosynostosis, microcephaly, achondroplasia, facial clefts, cleft lip (cheiloschisis), cleft jaw (gnathoschisis), cleft palate (palatoschisis).
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **List** the dimensions of a skull of a newborn.
- **Explain** what is happening on histological level at each stage of desmogenous and chondrogenous ossification.
- **Differentiate structurally** between bones of chondrocranium and desmocranium. Name at least two bones as examples for each of these parts of skull.
- **Describe** parts of skeleton developing from the mesenchyme of pharyngeal arches 1-4 and 6.
- **Explain** how the frontonasal, mandibular, maxillary and nasal prominences contribute to the development of human face.
- **Explain** the origin of primary palate and of secondary palate.
- **Explain** how the nasal cavity originates. Discuss the spatial relations between invaginating nasal pits, oronasal membrane, primary and secondary choanae, and the definitive hard palate.
- **Explain** the role of fontanelles and cranial sutures during the birth. At what age are the fontanelles ossified?
- **Explain** how the persistence of neuropores is related to developmental defects of brain, spinal cord, skull, and vertebral column.
- **Explain** which structures fail to fuse in lateral cleft lip, cleft upper jaw, and cleft secondary palate.
- **Predict** which developmental disorders result from abnormal and premature closure of cranial sutures.
- **Predict** which bones will be affected by a genetic disorder affecting formation of bone from cartilage (such as achondroplasia). Which bones will develop to a relatively normal size despite this genetic disorder?

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# Goals and outcomes - Development of skeleton, limbs, muscles and skin. (Embryology chapter 12)

*This chapter overlaps with Chapter 11 (Development of head and skull)*

**Be able to:**

- **Define and use:** paraxial mesoderm, somatopleuric lateral plate mesoderm, segmentation, somite, sclerotome, resegmentation of sclerotomes, vertebral body, notochord, neural processes, transverse and costal processes, sternal bar, limb buds, autopod, zeugopod, stylopod, apical ectodermal ridge, desmogenous and chondrogenous ossification, primary and secondary ossification centers, diaphyses and epiphyses, bone age, meromelia, amelia, phocomelia, syndactyly and polydactyly, clubfoot and congenital hip dislocation, spina bifida, myotome, epimeric (epaxial) and hypomeric (hypaxial) muscles, myoblasts and myotubes, neural crest, dermatome, mesenchyme, melanocytes, vernix caseosa, lanugo, mammary ridge, polythelia and polymastia
- **Draw** and **label** simplified developmental schemes specified in a separate document.
- **Name** the three proximal to distal parts, into which the developing limbs are organized. Which bones originate in these regions in the upper and which in the lower limb?
- **Name** examples of muscles developing from epimeric (epaxial) and hypomeric (hypaxial) parts of myotomes.
- **Name** the spinal cord segments innervating muscles of the upper and the lower limb.
- **Name** the embryonic source of melanocytes of the skin.
- **Explain** what happens with the notochord during the development of vertebral column.
- **Explain** what is happening at each stage of ossification of long bones. How do the histological zones of the epiphyseal growth plate contribute to the bone development?
- **Compare** the ossification of diaphysis and epiphyses in long bones.
- **Explain** why the ectodermal apical ridge is important for development of handplate and footplate.
- **Describe** which parts of the somites retain their original segmentation pattern and which parts undergo resegmentation.
- **Explain** how the vertebral body originates from adjacent sclerotomes.
- **Explain** how the ribs and the sternum originate.
- **Explain** how the innervation of masticatory, facial, pharyngeal and laryngeal muscles is linked to the nerves of embryonic pharyngeal arches.
- **Explain** how and through which transitional stages the multinucleated skeletal muscle fibers develop.
- **Compare** the pattern of dermatomes along the limbs with the pattern along the thorax and abdomen.
- **Predict** what would happen if the rearrangement of segmental sclerotomes would partially or completely fail?
- **Predict** which conditions develop when accessory breasts glands or nipples persist within the range of the mammary ridge. In which anatomical regions might these occur?
- **Predict** which developmental defects may occur as a consequence of oligohydramnion?

*Department of Histology and Embryology, Faculty of Medicine in Pilsen, Charles University, Czech Republic;* 

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