Embryology

| System | Normal Development | Abnormal Development |
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| **General Embryology** | - Gametogenesis (spermatogenesis, oogenesis) - Fertilization, cleavage, implantation - Germ layer formation (ectoderm, mesoderm, endoderm) - Neurulation and folding - Embryonic and fetal circulation - Placental and umbilical development | - Teratogenesis (environmental, genetic, infectious) - Chromosomal abnormalities (aneuploidy, translocations) - Congenital malformations (multifactorial inheritance) |
| **Hematopoietic & Lymphoreticular** | - Hematopoiesis (yolk sac → liver → bone marrow) - Development of lymphoid organs (thymus, spleen, lymph nodes) | - Congenital immunodeficiencies (DiGeorge syndrome – thymic aplasia) - Hemoglobinopathies (sickle cell, thalassemia) |
| **Central & Peripheral Nervous** | - Neural tube formation and closure - Brain vesicle development (forebrain, midbrain, hindbrain) - Spinal cord and neural crest derivatives - Myelination and neuronal migration | - Neural tube defects (anencephaly, spina bifida, encephalocele) - Hydrocephalus, microcephaly, holoprosencephaly - Chiari and Dandy-Walker malformations - Congenital cranial nerve defects |
| **Skin & Connective Tissue** | - Epidermis and dermis differentiation - Hair, nails, and sweat gland formation - Development of connective tissues (cartilage, tendons, ligaments) | - Albinism, ichthyosis, epidermolysis bullosa - Ehlers-Danlos syndrome, Marfan syndrome |
| **Musculoskeletal** | - Limb bud formation, segmentation - Endochondral and intramembranous ossification - Muscle differentiation and migration | - Limb abnormalities (polydactyly, syndactyly, amelia, phocomelia) - Achondroplasia, osteogenesis imperfecta, congenital scoliosis |
| **Respiratory** | - Lung bud formation (week 4) - Bronchial branching morphogenesis - Alveolar development and surfactant production | - Tracheoesophageal fistula - Pulmonary hypoplasia (e.g., Potter sequence) - Congenital diaphragmatic hernia |
| **Cardiovascular** | - Heart tube formation and looping - Aortic arch and great vessel development - Septation of atria and ventricles - Fetal circulation changes at birth | - Congenital heart defects (ASD, VSD, Tetralogy of Fallot, transposition of great arteries) - Patent ductus arteriosus, coarctation of the aorta |
| **Gastrointestinal** | - Gut tube formation and rotation - Liver, pancreas, and biliary system development - Enteric nervous system formation | - Malrotation, volvulus, intestinal atresia - Meckel's diverticulum, omphalocele, gastroschisis - Hirschsprung disease (aganglionosis) - Annular pancreas, biliary atresia |
| **Renal/Urinary** | - Kidney development (pronephros → mesonephros → metanephros) - Ureteric bud and nephron formation - Bladder and urethra development | - Renal agenesis, polycystic kidney disease - Horseshoe kidney, vesicoureteral reflux - Urachal abnormalities (patent urachus) |
| **Reproductive** | - Gonadal differentiation (testis, ovary) - Müllerian (paramesonephric) and Wolffian (mesonephric) duct development - External genitalia formation | - Disorders of sexual development (androgen insensitivity, Turner syndrome) - Cryptorchidism, hypospadias, epispadias - Müllerian agenesis, uterine malformations |
| **Endocrine** | - Development of hypothalamus, pituitary, thyroid, adrenal glands - Pancreatic islet cell formation | - Congenital adrenal hyperplasia - Thyroid dysgenesis, ectopic thyroid - Diabetes-related genetic syndromes |