

EMBRYOLOGY

COURSE CONTENT

COMPETENCIES

The first year medical student should be able to understand and explain the principles of fertilization, contraception, stages of early development of the embryo, development of various organ systems; developmental basis of congenital defects, twinning and teratology.

GENERAL EMBRYOLOGY

INTRODUCTION

Stages of human life

Prenatal - Zygote, pre-embryonic, embryonic, foetal, birth events

Postnatal - Neonatal, infancy, childhood, prepubertal, pubertal, adolescent, adult - young, middle age, old age, death events

Ontogeny, trimester, viability, abortion, miscarriage, medical termination of pregnancy, conceptus, abortus

Terms of reference – Cranial, rostral, caudal, dorsal, ventral, lateral, medial, median, planes of section

Level 3: Ontogeny in relation to phylogeny - The law of recapitulation; "Critical period"; Congenital *vs.* hereditary malformations; Investigations - USG, amniocentesis, chorionic villus biopsy, fetoscopy, teratology and its significance with respect to obstetrics, paediatrics; Intrauterine surgery; History of embryology

GAMETOGENESIS AND FERTILISATION

Menstrual cycle with reference to other reproductive cycles, concept of "first day of last menstrual period", germ cell transport and fertilisation, sperm capacitation, acrosome reaction, zona reaction, methods of contraception, sex determination

Level 2: Reference to genetics, abnormal gametogenesis, abnormal germ cells - morphology, abnormal chromosomal contents, biological significance, conception, assisted reproductive techniques (ARTs), medical termination of pregnancy (MTP)

Level 3: Abnormalities which may occur during mitosis and meiosis due to natural or teratogenic influences; Fertility and sterility and investigations thereof up to sex selection, surrogate motherhood; Social significance of "sex-ratio", ethics and responsibility

FIRST WEEK

Cleavage, compaction, morula, blastocyst; Implantation - normal sites, abnormal sites - placenta praevia

SECOND WEEK

Cytotrophoblast, syncytiotrophoblast; Foetal membranes - chorionic villi, amnion, yolk sac; Extra-embryonic mesoderm and coelom; Bilaminar disc - prochordal plate

Level 2: Mosaicism, chimera; Spontaneous "abortion"; Tubal transport and block

Consequences of abnormal implantation; Decidual reaction, chorionic gonadotropins - pregnancy test, inhibition of implantation

Level 3: Pregnancy wastage, appreciating dangers of abnormal implantation, corrective methods; Pregnancy tests - false positive, false negative and reasons for the same

THIRD WEEK

Gastrulation - Primitive streak - formation and significance; Notochord; Neurulation – neural tube and its fate, neural crest cells - their fate; Development of somites; Intra-embryonic coelom, CVS; Allantois; Inductive significance of structures

Level 2: Congenital malformations - Sacrococcygeal teratomas, neural tube defects, spina bifida, meningocele, anencephaly

Level 3: Signs of pregnancy in the first trimester; “Frame of body” - poles, axis, symmetry; Role of teratogens in first trimester; Dilatation and curettage procedure, suction curettage, alpha fetoprotein levels

FOLDING OF THE EMBRYO

Derivatives of germ layers, concept of critical period, pharyngeal arches (pharyngula stage)

Level 2: Dymorphism, histologic significance, tissue organisation in terms of germ layers

Level 3: Thalidomide tragedy- historical significance, role of “testing of drug or agent” as teratogen, animal experiments; Estimation of embryonic age - crown-rump length (CRL), somites; Superfoetation & superfoecundation

FETAL MEMBRANES

Features, formation, functions, fate of: Chorion; Amnion; Yolk sac; Allantois; Decidua; Umbilical cord; Placenta - Physiological functions; Fetomaternal circulation, Placental barrier, Twinning - monozygotic, dizygotic

Level 2: Role of placental hormones, uterine growth, parturition, multiple pregnancy.

Level 3: Details of placenta, post-labour examination - information available, types; Types of cord attachments, abnormal multiple pregnancy, inclusions; Variety of uses of amniotic membranes, trophoblastic tumours - benign and malignant; Rh incompatibility, haemolytic disease of newborn, erythroblastosis fetalis, teratogenic influences

FETAL PERIOD

The growth of the fetus in general in terms of weight and major features; maternal-fetal correlation during pregnancy (pregnancy changes in mother)

Level 2: Estimation of fetal age, concept of prematurity; Relative proportion of body segments; Some details of tissue differentiation and development of function

Level 3: Cytogenetics, chorion villus biopsy and amniocentesis; Causes of “small” and “large” babies; Concept of small for date (age) growth; Factors influencing fetal growth; Older methods of fetal monitoring, their hazards; Estimation of fetal age - crown-heel length (CHL)

TERATOGENESIS

Enumeration of factors causing congenital malformations with examples

Level 2: Brief clinical manifestations and details with genetic basis

Level 3: Concept of critical period, teratogens; Multifactorial inheritance; Methods available to correct or palliate e.g. In Utero Surgery; Genetic engineering; Stem cell transplants

BODY CAVITIES, PRIMITIVE MESENTERIES AND DIAPHRAGM

Coelomic cavity; its subdivisions; Related parts i.e., cardiogenic area, septum transversum, somatopleure, splanchnopleure, mesenteries formation, Functions and fate; Development of diaphragm

Level 2: Enumeration of congenital malformations; Diaphragmatic hernias

Level 3: Clinical presentation; Neonatology; Respiratory distress; Herniations; Attempts at intrauterine surgery to correct malformations

General Embryology Models

- Gametogenesis - Oogenesis; Spermatogenesis; Structure of spermatozoon
- Cell division - Mitosis; Meiosis
- Germ disc showing - Primitive streak; Notochordal process and Prochordal plate
- Folding of the embryo and somites
- Placenta and foetal membranes

SYSTEMIC EMBRYOLOGY

CARDIOVASCULAR SYSTEM

General principles of angiogenesis; Sinus venosus - venous system; Heart - chambers, septa; Truncus - formation and fate; Aortic arches - arterial system; Fetal circulation - changes at birth; Lymphatic system; Anomalies - ASDs, VSDs, PDA, Fallot's tetralogy

Level 2: Development of major veins, Correlation with gross anatomy and commonly occurring anomalies; Anomalies of the lymphatic system

Level 3: Clinical features; Latest developments including prosthetic valves, graftings, transplantation; Surgical corrections

RESPIRATORY SYSTEM

Development of larynx, trachea, bronchi, lungs; tracheo-oesophageal fistula

Level 2: Other anomalies

Level 3: Respiratory distress syndrome; Premature births and consequent necessary care with respect to respiratory system

ALIMENTARY SYSTEM

Foregut - Oesophagus, stomach, mesenteries and omental bursa (lesser sac); duodenum, hepatobiliary apparatus, pancreas, spleen

Midgut - Rotation and fixation, caecum and appendix, Meckel's diverticulum

Hindgut - Cloaca; Digestive tract / urogenital tract derivatives; Rectum and anal canal
Arteries of Foregut, Midgut, Hindgut

Level 2: Malformation - review; Tracheo-oesophageal fistula; Congenital hypertrophic pyloric stenosis; Atresia; Omphalocele; Hernia; Situs inversus; Nonrotation; Mixed rotation

Level 3: Clinical presentation in premature births and neonatal period

PHARYNGEAL ARCHES AND FACE

Ectodermal clefts - cervical sinus, auricle; Mesodermal derivatives - skeletal, muscle mass, arterial arches; Endodermal pouches - tongue, thyroid, parathyroid, thymus, tubotympanic recess; Pre and posttrematic nerves

Mandibular process, maxillary process, frontonasal process; Cleft lip, cleft palate

Level 2: Branchial cyst, sinus, fistula; Other congenital anomalies of the glands; Oblique facial cleft; Other congenital anomalies of the face

Level 3: Treacher Collins syndrome; Genetic basis of teratology

UROGENITAL SYSTEM

Along with vascular pattern and development; Development of kidneys and ureters; Cloaca - urinary bladder and urethra; Genital system - testis and ovary; Ducts and associated glands; External genital organs; Mesonephric and paramesonephric ducts; Uterine tube, uterus and vagina

Level 2: Enumeration of congenital malformations with their explanations; Ambiguous genitalia and hermaphroditism; Remnants and vestiges of ducts and tubules

Level 3: Clinical presentation and visualisation in the living; Hernia, hydrocoele; Relevance to forensic medicine

ENDOCRINE GLANDS

Pituitary - Rathke's pouch, neural tube extension; Thyroid & parathyroid - pharyngeal pouches; Suprarenal - intermediate mesoderm, neural crest

Level 2: Histogenesis; Congenital anomalies

NERVOUS SYSTEM

Neural tube - spinal cord and brain i.e., forebrain, midbrain and hindbrain, ventricular system, hypophysis cerebri; Neural crest - peripheral nervous system, i.e., somatic and autonomic; Principle of neurobiotaxis - correlation with gross and histogenetic neuroanatomy; Functional components - correlation spina bifida; Anencephaly, hydrocephalus, functional components of peripheral nerves

Level 3: Sequence of myelination of tracts T3-T4; Relative shortening of spinal cord vis-à-vis vertebral column - therefore longer nerve roots, more liable to compression; Genetic and teratologic factors in neural tube defects

ORGANS OF THE SPECIAL SENSES

Eye - General organization; Enumeration of each component starting from its development; Include reference to adnexa

Level 2: Common anomalies; Retinal detachment; Congenital glaucoma; Coloboma iris; Congenital cataract and aphakia

Level 3: Genetics and teratology especially rubella, toxoplasmosis; "TORCH" Test; Clinical detection of small functional problems related to the eye

Ear - Internal ear - Membranous and bony labyrinth; External and middle ear - Review common anomalies of the ear

SKELETAL SYSTEM

Bones and joints; General development of cartilage and bone ossification; Joints; Axial and Appendicular skeleton, vertebrae, ribs

Level 2: Abnormalities of development; Gross and microanatomy correlations

Level 3: Neural tube defects - Related consequences; Genetics and endocrinology;
Radiological and forensic significance of ossification

MUSCULAR SYSTEM

Myotomes; Local differentiation of muscles, myotomic fusions; Splits and migrations;
Correlation with motor innervation

Level 2: Common anomalies; anatomic variations

Level 3: Rare syndromes of muscular defects and deficiencies - Genetics

LIMBS

General principles; Rotations - dermatomal distribution; Review vascular pattern

Level 2: Congenital malformations

Level 3: Genetic and Teratologic influence in limb; development and anomalies

INTEGUMENTARY SYSTEM

Skin - Non-hairy; Hair (Pilo-sebaceous unit); Nails; Sweat glands; Mammary glands;
Tooth as a modified dermal papilla

Level 2: Congenital anomalies, especially with respect to pigment, sweat glands,
vessels, nerves, lymphatics; Mammary gland anomalies

Level 3: Genetics and teratology; Clinical syndromes

Systemic Embryology Models

- Alimentary System - Rotation of gut
- Development of stomach, pancreas and liver
- Circulatory System - Chambers of the heart
- Development of interatrial septum
- Development of interventricular septum
- Urogenital System - Septation of hindgut
- Development of kidney
- Derivatives of paramesonephric duct
- Derivatives of mesonephric duct
- Alimentary System - The Branchial apparatus & tongue
- Development of face & palate
- Nervous System - Brain vesicles and their development
- Neural crest cells and their derivatives

LECTURES

- Male gametogenesis
- Female gametogenesis
- 1st week of development
- 2nd week of development
- 3rd week of development
- 4th to 8^h week of development
- Placenta & membranes
- Twinning and teratogenesis
- Heart - Exterior
- Heart - Interior
- Arteries
- Veins
- Foetal circulation; Lymphatics
- Anomalies
- Respiratory system
- Foregut - caudal part
- Midgut
- Hindgut
- Anomalies
- Upper urinary tract - Kidney & ureters
- Lower urinary tract - Urinary bladder & urethra
- Male reproductive system
- Female reproductive system
- Anomalies
- Integumentary system
- Development of endocrine glands
- Pharyngeal arches
- Development of face
- Muscular system
- Skeletal system
- Development of spinal cord & histogenesis
- Development of brain
- Anomalies of nervous system
- Development of eye & ear
- Postnatal growth & development

Topics for integration

- Paediatric anatomy
- Assisted Reproductive Techniques (ARTs)

Karl Ernst Von Baer
(1792-1876)



He was an Estonian zoologist.

He is referred to as the “Father of Modern Embryology” and the founder of comparative embryology.

He described the development of many vertebrate types.