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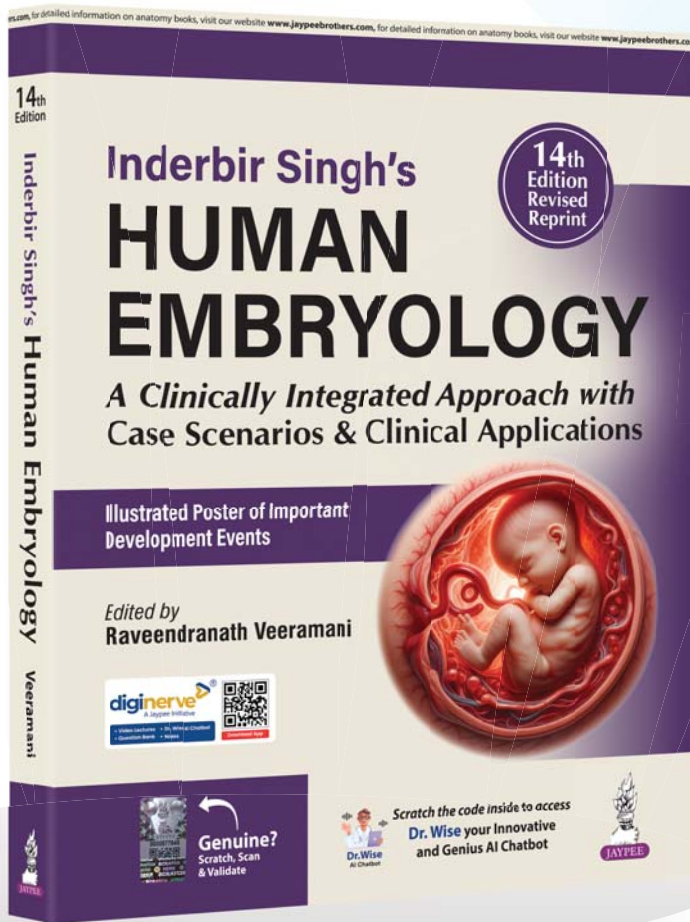
Inderbir Singh's HUMAN EMBRYOLOGY

*A Clinically Integrated Approach with
Case Scenarios & Clinical Applications*

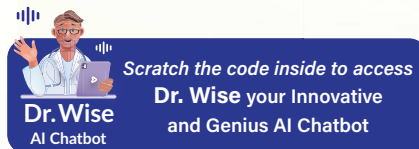
**Illustrated Poster of Important
Development Events**

**Revised and updated as per latest
CBME curriculum by NMC (2024).**

**Edited by
Raveendranath Veeramani**



14th Revised
Edition Reprint



Why to Buy this Book ?

- Organized updated content: Coverage of topics aligned with the National Medical Commission (NMC) competencies which are thoroughly updated and presented in a comprehensive yet concise manner, making them accessible and relevant to students.
- Student-friendly images: High-quality, detailed line diagrams which are easily reproducible and accompany the text to enhance understanding of complex concepts.
- Clinical correlations: Integration of clinical correlations throughout the text, connecting embryological concepts to clinical practice and highlighting their relevance in medical scenarios with relevant clinical images.
- Timelines of developmental events: Clear and concise timelines that outline the key developmental events at each stage, helping students grasp the chronological progression of embryogenesis.
- Summary and flowcharts for rapid revision: Simplified flowcharts and summaries at the end of chapter provide critical information, aiding in quick revision and reinforcing key concepts.
- Chapter highlights: Key points highlighting the essential points, ensuring that students can review and retain important information effectively.
- Reasoning and review questions: Practice and thought-provoking questions at the end of each chapter designed to test comprehension and encourage critical thinking.
- Self-assessment multiple choice questions (MCQs): A variety of MCQs for self-assessment, enabling If any reader wishes to share feedback, suggestions, updates, and errata, please students to evaluate their understanding and prepare for exams.

SAMPLE PAGES

Second Week of Development

5
CHAPTER

COMPETENCIES COVERED/LEARNING OUTCOMES

The student should be able to:

- AN7B.2 Describe the development of trophoblast.
- AN7B.4 Describe the formation of extraembryonic mesoderm and coelom, bilaminar germ disc and prochordal plate.

Competencies/Learning Objectives

NOTE

- Hypoblast is the first germ layer to be formed.
- Reorganization of cells of inner cell mass into hypoblast and epiblast occurs before completion of implantation of conceptus.

Notes

Clinical Importance

Clinical Importance

Hydatidiform Mole/Molar Pregnancy

- Abnormal form of pregnancy/conceptus where non-viable fertilized egg is implanted in the uterus and it fails to continue until term.
- The trophoblast develops and forms fetal membranes (placenta) but, the embryonic tissue is little or absent.
- In this condition, the embryo dies but there is abnormal growth of trophoblast. Cystic swellings resembling a bunch of grapes that develop from the degenerating and avascular villi.
- **Types:** There are two types of hydatidiform mole:
 1. **Complete mole:** It is caused by a single sperm or two sperms combining with an oocyte having no female pronucleus. Hence, no embryo is seen.
 2. **Partial mole:** A normal oocyte combines with one or two sperm which then reduplicates resulting triploid or tetraploid genotypes. In this condition, a part of embryo is seen.
- **Diagnosis is by:**
 - Ultrasound that shows snowstorm appearance of uterine cavity.
 - Appearance of vesicles in urine. No fetal movements and fetal heart sounds.
 - High levels of human chorionic gonadotropin (hCG) after two months of pregnancy suggests hydatidiform mole.
- Moles can undergo malignant change and form choriocarcinoma. The chances of developing choriocarcinoma are 10-15% for complete moles.
- **Treatment:** Evacuating the contents of uterus by uterine suction immediately after diagnosis to avoid the risk of choriocarcinoma.

Immunological Rejection of Conceptus by the Mother

- The antigens expressed by the fetus and placenta are different from that of the mother. But they are not rejected by the maternal immune system during pregnancy.
- Implantation of an embryo brings changes in the DNA packaging of chemokine genes of the stromal cells of decidua. This permanently deactivates, or "silences," the expression of chemokine genes and recruitment of T cells to the site of implantation.

Case Based Learning

Case Based Learning

Embryological Basis of Hydatidiform Mole (Molar Pregnancy)

Patient details: A 28-year-old woman, G1P0, presents at 10 weeks gestation with vaginal bleeding and severe nausea. She reports that this pregnancy was a long-awaited event for her and her husband. On examination, her uterus is larger than expected for gestational age. There is no fetal heartbeat on Doppler ultrasound.

Diagnostic Evaluation

- **Ultrasound:** Characteristic "snowstorm" appearance with the absence of a viable fetus.
- **β-hCG levels:** Elevated β-hCG levels disproportionate to gestational age.
- **Histopathology:** Examination of products of conception reveals hydropic villi with trophoblastic proliferation.

TABLE

Subdivisions and adult derivatives of neural tube.

Neural tube subdivisions	Primary brain vesicles	Secondary brain vesicles	Parts of adult brain	Cavities
Brain	Prosencephalon (forebrain)	Telencephalon	<ul style="list-style-type: none"> • Cerebral hemispheres • Cerebral cortex • Corpus striatum • Caudate nucleus • Lentiform nucleus 	Lateral ventricles
		Diencephalon	<ul style="list-style-type: none"> • Thalamus • Hypothalamus • Epithalamus 	Third ventricle
	Mesencephalon (midbrain)	Mesencephalon	Midbrain	Cerebral aqueduct
	Rhombencephalon (hindbrain)	Metencephalon	<ul style="list-style-type: none"> • Pons • Cerebellum 	Fourth ventricle
Spinal cord	Spinal cord	Myelencephalon	Medulla oblongata	Central canal
		Spinal cord	Spinal cord	

Tables

Clinical correlation

Several diseases and syndromes are associated with the disturbances of the neural crest, e.g., Hirschsprung's disease (aganglionic megacolon), aorticopulmonary septal defects of heart, cleft lip, cleft palate, frontonasal dysplasia, neurofibromatosis, tumor of adrenal medulla and albinism and others.

Clinical Correlation

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Clinical come

Several diseases and syndromes are associated with the disturbances of the neural crest, e.g., Hirschsprung's disease (aganglionic megacolon), aorticopulmonary septal defects of heart, cleft lip, cleft palate, frontonasal dysplasia, neurofibromatosis, tumor of adrenal medulla and albinism and others.

SPINAL CORD

The spinal cord is part of the neural tube.

When this part of

clarity is in the form of a dorsoventral (dorsal) tube. The lateral walls are thick, but the roof (dorsal), and the floor (ventral), are thin (Fig. 22.7A). The wall of the tube subdivides into the mantle cell or ependymal layer, the mantle layer and the marginal layer (Fig. 22.7B) as already described in Chapter 10.

The mantle zone grows faster in the ventral part of the neural tube, and becomes thicker than in the dorsal part. As a result, the ventral part of the lumen of the neural tube becomes compressed. The line separating the compressed ventral part, from the dorsal part, is called the sulcus limitans (Fig. 22.7C).

With its formation, the lateral wall of the developing spinal cord can be divided into a dorsal part, called

Roof plate

Further enlargement of the basal lamina causes it to project forwards on either side of the midline, leaving a furrow, the anterior median fissure, between the projecting basal laminae of the two sides.

The nerve cells that develop in the mantle zone of the basal lamina become the neurons of the anterior gray column (Fig. 22.8). The axons of these cells grow out the ventrolateral angle of the spinal cord to form the anterior/ventrolateral nerve roots of the spinal nerves.

The nerve cells that develop in the mantle layer of the alar lamina form the neurons of the posterior gray column. These are sensory neurons of the second

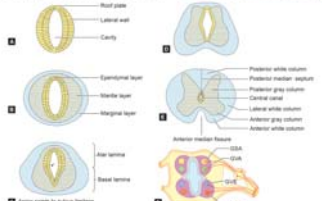


FIG. 22.7A-F Development of spinal cord. (A) Single-layered neural tube. (B) Ependymal, mantle and marginal layers established. (C) and (D) mantle layer divided into ependymal and basal laminae. (E) Ventral and dorsal gray columns established. The dorsal part of the cavity of the neural tube disappears. The ventral part persists as the central canal. (F) Functional columns of mature

Highlights

HIGHLIGHTS

- Nervous system develops from the specialized ectoderm overlying the notochord known as **neuroectoderm**.
- Neuroectoderm overlying the notochord becomes thickened to form the **neural plate**.
- Neural plate is converted to **neural groove**, and then to **neural tube**.
- Neural tube has an enlarged cranial part that forms the **brain**, and a narrow caudal part that becomes the **spinal cord**. Neural tube presents a **central cavity** (lumen) that contains cerebrospinal fluid and a **peripheral wall** that forms **nervous tissue**.
- The cranial part of neural tube shows three dilations: **prosencephalon**, **mesencephalon** and **rhombencephalon**.
- The prosencephalon divides into diencephalon and telencephalon. The telencephalon forms most of the **cerebral hemisphere** including the **corpus striatum**. The **lateral ventricle** is the cavity of the telencephalon. The diencephalon forms the thalamus, hypothalamus and related structures. Its cavity is the **third ventricle**.

Chapter 22 Nervous System 303

TIMETABLE OF SOME EVENTS DESCRIBED IN THIS CHAPTER

Age	Developmental events
3rd week	Neural tube begins to form
4th week	Neural folds begin to fuse
4th week	Primordia of sensory ganglia (dorsal and cranial) are formed
4th week	Formation of primary brain vesicles
25th day	Closure of anterior neuropore
25th day	Closure of posterior neuropore
28th day	The most cranial part of cervical spinal ganglia develops
30th week	Formation of brain vesicles
30th week	Sympathetic ganglia are formed. Cerebral hemispheres begin to form
8th week	Cardiac septum forms
52th week	The corpus callosum forms
12th week	Cerebellar cortex and Purkinje cells are formed
15th week	The dentate nucleus is seen
4th month	Myelination of nerve fibers begins
Late fetal life	Sulci and gyri appear over cerebral hemispheres

Core Based Learning

Summary

Summary

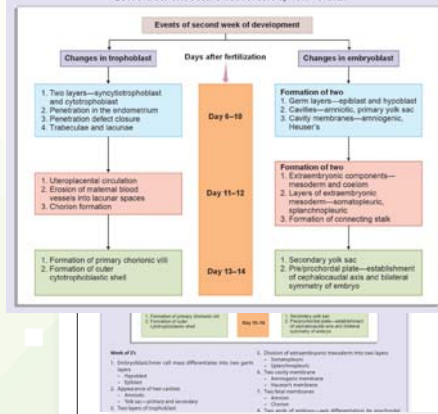
- Subdivisions and adult derivatives of neural tube (Figs 22.2 and 22.3).**
- Flexures of neural tube:**
 - Cervical
 - Pontine
 - Mesencephalic
- Neural crest cell derivatives (Fig. 22.6):**
 - Dorsal mass:** Neurons of dorsal root ganglia and sensory ganglia of 5th, 7th, 8th, 9th and 10th cranial nerves; capsular and Schwann cells, melanoblasts and leptomeninges.
 - Ventral mass:** Neurons of sympathetic ganglia and peripheral parasympathetic ganglia; suprarenal medulla and para-aortic bodies.
 - Others:** Bones of face and vault of skull, sclera and choroid of eye, C cells of thyroid gland.

- The cranial part of neural tube shows three dilations: prosencephalon, mesencephalon and rhombencephalon.
- The prosencephalon divides into diencephalon and telencephalon. The telencephalon forms most of the cerebral hemisphere including the corpus striatum. The lateral ventricle is the cavity of the telencephalon. The diencephalon forms the thalamus, hypothalamus and related structures. Its cavity is the third ventricle.

Flow Charts

taking place during the second week of germinal period (Flowchart 5.1).

FLOWCHART 5.1: Second week of development—events.



MULTIPLE CHOICE QUESTIONS

- Which is called as primitive ectodermal layer?
 - Ectoderm
 - Epidermis
 - Neuroectoderm
 - Neurulation
- Which cells are attached to the extraembryonic mesoderm of blastocyst and cytotrophoblastic shell of maternal side?
 - Syncytiotrophoblast
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
- "Neurulation" appearance of anterior cavity in ECG is
 - Chorionic cavity
 - Amniotic cavity
 - Embryonic cavity
 - Primary yolk sac
- Endodermal layer of EGF is formed from:
 - Epiblast
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
- During the second week of human embryonic development, which of the following structures undergoes differentiation to form the bilaminar embryonic disc?
 - Amniotic cavity
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
- In the second week of human embryonic development, what structure gives a vascularized lining the placenta and facilitates nutrient exchange between the embryo and mother?
 - Amniotic cavity
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
- At 16 days after fertilization, the embryo is approximately 0.5 mm long. Which embryonic structures are primarily responsible for the production of hormones that maintain the early pregnancy and contribute to her pregnancy?
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
 - Embryonic epiblast
- What is the fate of the cytotrophoblastic cells during the second week of human embryonic development?
 - They differentiate into the ectoderm and hypoderm layers.
 - They form the amniotic cavity.
 - They contribute to the formation of the yolk sac.
 - They form the inner layer of the chorionic villi.
- A 16-year-old woman presents for her first prenatal visit at 8 weeks gestation. Ultrasound reveals a developing embryo with visible heart motion. Which embryonic structure is primarily responsible for the formation of the fetal blood vessels that will eventually connect to the placenta?
 - Embryonic epiblast
 - Amniotic cavity
 - Primary yolk sac
 - Embryonic epiblast

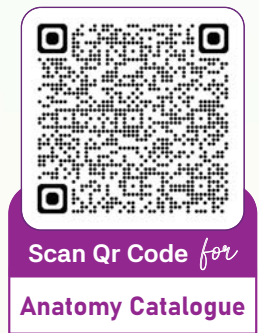
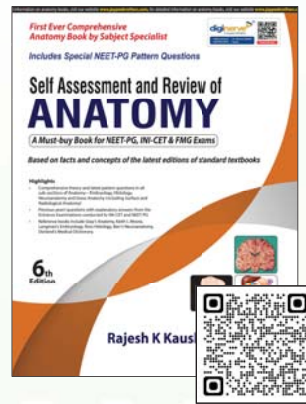
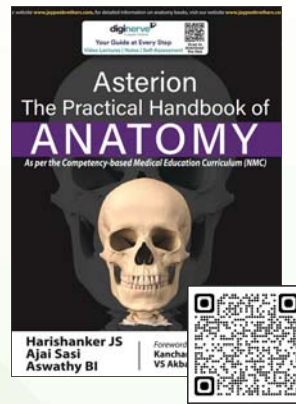
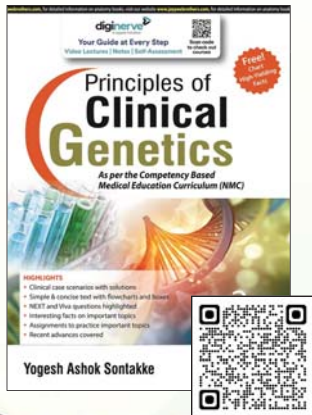
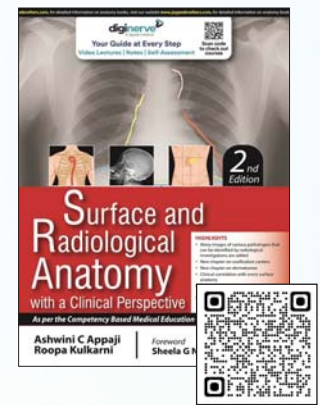
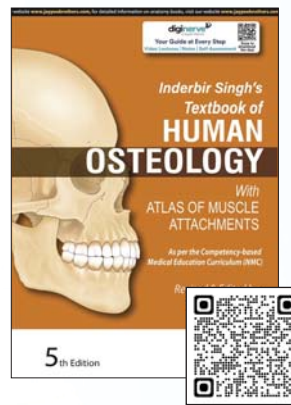
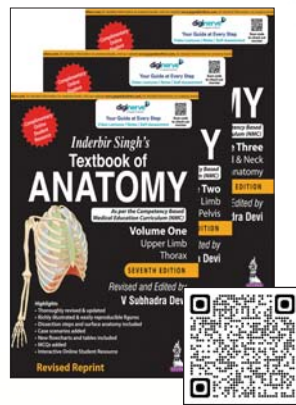
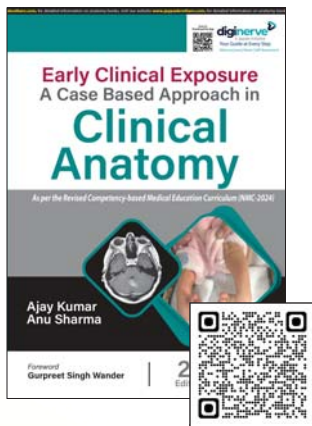
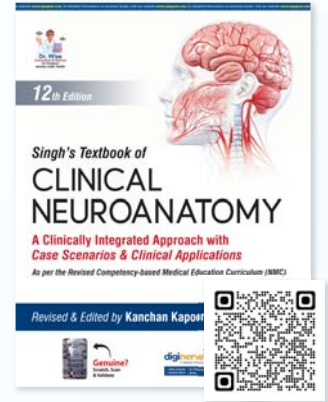
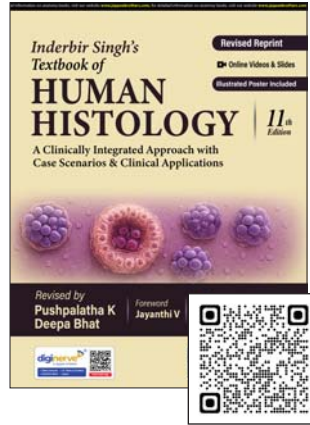
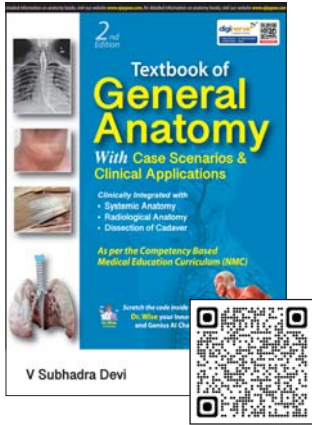
Test Your Understanding

- Review Questions
 - Explain Why?(Reasoning Questions)
 - Multiple Choice Questions
- Give at the end of each chapter.

REVIEW QUESTIONS

- What roles do the syncytiotrophoblast and cytotrophoblast play in development?
- Explain the formation of chorionic villi.
- Discuss the formation of amniotic cavity and its significance.
- What is the role of the hypoblast in early embryonic development?
- Describe the changes that occur in the trophoblast during the second week of human development.
- What is the significance of lacunae formation in the syncytiotrophoblast?
- What is the function of human chorionic gonadotropin (hCG) secreted by the syncytiotrophoblast?

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