Chapter 4. General Embryology

1 Learning Objectives

On completing this chapter, students will be able to …

1. **Outline the timeline of early human development** from gametogenesis to week 8.
2. **Describe key processes**—fertilisation, cleavage, blastocyst formation, implantation, gastrulation and embryonic folding.
3. **Name the three primary germ-layers** and at least **three musculoskeletal or nervous derivatives** of each.
4. **Explain how errors in early development lead to common congenital anomalies** (e.g., neural-tube defects, limb-bud malformations) that influence physiotherapy management.
5. **Apply embryological concepts** to neonatal, paediatric and lifelong rehabilitation scenarios.

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2 Developmental Timeline (Weeks 0 – 8)

Stage	Post-Fertilisation Period	Key Events	Clinical / PT Relevance
Gametogenesis	*Before week 0*	Oogenesis & spermatogenesis; meiosis yields haploid gametes	Maternal age ↑ → meiotic errors → trisomies → developmental delay & hypotonia requiring early-intervention PT
Fertilisation	Day 0	Sperm penetrates zona pellucida in ampulla of uterine tube → zygote (46 XX/XY)	Determines genetic sex; X-linked disorders (e.g., DMD) shape future PT plans
Cleavage	Day 1-3	Rapid mitoses → morula (16 cells)	High metabolic demand—vulnerable to teratogens
Blastocyst	Day 4-5	Inner cell mass (embryoblast) & trophoblast; zona sheds	Trophoblastic invasion issues ↔ placenta previa → prematurity (NICU physiotherapy)
Implantation	Day 6-10	Syncytiotrophoblast embeds in endometrium; hCG secreted	Faulty implantation → ectopic pregnancy; high clinical importance but minimal PT role
Bilaminar disc	Week 2	Epiblast + hypoblast; amniotic & chorionic cavities form	Amniotic fluid dynamics later influence limb development
Gastrulation	Week 3	Primitive streak → **ectoderm, mesoderm, endoderm**	Mis-closure of neural tube → spina bifida (requires life-long physio)
Neurulation	Week 3-4	Neural plate folds → neural tube & neural crest	Cerebral palsy risk ↑ with brain malformations
Somite segmentation	Week 3-5	Paraxial mesoderm → 42-44 pairs somites (sclerotome, dermomyotome)	Dictates myotome/dermatome maps used in neuro-assessment
Embryonic folding	Week 4	Converts flat disc → cylindrical embryo; incorporates yolk sac	Ventral wall defects (omphalocele) affect post-surgical PT
Limb-bud formation	Week 4-5	Apical ectodermal ridge (AER) drives proximodistal growth	Amelia/phocomelia influence adaptive equipment prescription
Organogenesis	Week 4-8	All major organs established	Teratogen susceptibility → cardiac defects (post-op cardio-pulmonary rehab)

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3 Germ Layers & Selected Derivatives

Germ-Layer	Musculoskeletal / Neuro Derivatives	Other Major Derivatives
Ectoderm	Neural tube → **brain, spinal cord**; Neural crest → **peripheral nerves, Schwann cells**; Surface ectoderm → **epidermis**	Lens, inner ear, enamel
Mesoderm	Paraxial → **skeletal muscles, axial skeleton**; Lateral plate → **limb bones, cardiac & smooth muscle**; Intermediate → **urogenital organs**	Dermis, blood vessels
Endoderm	— (no direct MSK structures)	Epithelia of GI & respiratory tracts, liver, pancreas, bladder

PT Pearl: Recognising that skeletal muscle and vertebrae share the same somite origin helps explain co-occurrence of congenital muscular torticollis and cervical vertebral anomalies.

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4 Common Developmental Errors & Physiotherapy Implications

Anomaly	Developmental Mis-step	Prevalence	Key PT Considerations
Neural-tube defects (spina bifida, anencephaly)	Failed neural-fold closure (wk 3-4)	1 : 1 000 births	Wheelchair seating, contracture prevention, bladder training
Congenital limb deficiencies	Disrupted AER signalling	6 : 10 000	Prosthetic training, unilateral gait adaptations
Congenital muscular torticollis	Intrauterine positional or SCM fibrosis (later foetal period)	0.4 %	Passive stretch, caregiver education
Ventricular septal defect	Faulty cardiac septation (wk 5-6)	Most common CHD	Post-surgical chest physio, endurance management
Clubfoot (Talipes equinovarus)	Abnormal limb positioning / neuromuscular imbalance	1 : 1 000	Ponseti bracing compliance, strengthening

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5 Embryology ↔ Clinical Reasoning Flowchart

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javaCopyEditEarly insult (week 3) ➞ Neural-tube defect
            │
            ├➞ Lower-limb paralysis
            │        │
            │        ├➞ Muscle imbalance + ↓ weight-bearing
            │        │        │
            │        │        └➞ Osteopenia & contractures
            │        │
            │        └➞ Bladder dysfunction
            │                 └➞ Skin integrity issues
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PT GOALS: prevent deformity • optimise mobility • train caregivers • integrate seating & orthoses
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(Adapt the logic chain for other anomalies during case discussions.)

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6 Self-Check Quiz

1. **Which embryonic week is most sensitive to teratogen-induced cardiac defects?**
2. **Name the signalling molecule secreted by the notochord that patterns the neural tube.**
3. True/False: The diaphragm develops solely from septum transversum mesoderm.
4. Match the germ-layer with one derivative relevant to PT:

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a) Mesoderm — ___ ; b) Ectoderm — ___ ; c) Endoderm — ___
5. Explain how somite segmentation is reflected in adult physiotherapy assessment charts.

Answers

1. Weeks 3-6 (organogenesis, esp. wk 5-6 for heart).
2. **Sonic Hedgehog (SHH).**
3. False — also pleuroperitoneal membranes, dorsal mesentery of oesophagus, muscular ingrowth from body wall.
4. a) Quadriceps femoris muscle, b) Peripheral nerve, c) Respiratory epithelium.
5. Dermatome & myotome maps correspond to original somite levels, guiding neuro-screens.

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7 Suggested Lab / Tutorial Activities

1. **3-D Embryo Atlas Walkthrough:** Use virtual reality or apps (e.g., 3D Embryo) to visualise folding and limb-bud outgrowth.
2. **Neural-Tube Defect Simulation:** Apply orthoses to a mannequin with simulated L4 lesion; practise transfer techniques.
3. **Teratogen Debate:** Small groups present cases on alcohol vs. valproate exposure and long-term rehab outlook.

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8 Key Take-Home Points

- Early embryonic events dictate the **anatomical baseline** upon which physiotherapists build interventions across the lifespan.
- Understanding **germ-layer origins and critical periods** sharpens clinical reasoning for congenital and paediatric cases.
- Congenital anomalies often present **multi-system challenges**—effective PT integrates musculoskeletal, neurological and cardiopulmonary principles.