General Embryology
2nd Grades
Lecturer: **Sara Bahram** Miran
Topic: **Introduction to Embryology**
Date: **27/04/2025**

Introduction to Embryology: Language, Development, Growth, and Morphogenesis

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i. **Introduction: The Language of Embryology**
ii. **Embryological Terminology**
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v. **Differentiation**
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I. Introduction: The Language of Embryology

- Embryology, like anatomy, uses precise descriptive language, but special adaptations are necessary because the embryo does not adopt the adult anatomical position.
- Unlike the erect adult body (arms at sides, palms forward), the embryo is curved and folded.
- Anatomical descriptions in embryology rely on modified directional terms to account for embryonic posture.

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II. Embryological Terminology

1. Cranial–Caudal Axis

- **Cranial** = Head end (synonym: superior).
- **Caudal** = Tail end (synonym: inferior).
- **Rostral** can also be used for cranial, meaning 'toward the beak'.

2. Dorsal–Ventral Axis

- **Dorsal** = Back side (also the top of the brain, tongue, and foot).
- **Ventral** = Front (belly side) of the embryo.

3. Medial–Lateral Axis

- **Medial** = Near the midline (sagittal plane).
- **Lateral** = Farther from the midline.

4. Proximal–Distal Axis

- **Proximal** = Closer to the point of origin or the body's center.
- **Distal** = Farther from the body's center (e.g., the hand is distal to the elbow).

5. Embryonic Sections

- Planes of section include:
  - **Transverse** (cross-section),
  - **Median** (mid-sagittal),
  - **Coronal** (frontal),
  - **Oblique** (angled cuts).

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III. Introduction to Development

- Development refers to the transformation from a single-celled zygote to a fully formed, complex multicellular adult.
- It extends beyond birth into childhood, adolescence, and early adulthood.
- Key stages include:

    1. **Fertilization,**
    2. **Cell division and proliferation,**
    3. **Organization into tissues and organs,**
    4. **Growth and specialization.**

- **Clinical Insight**: Understanding normal development aids in recognizing how abnormalities and congenital defects arise.

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IV. Mechanisms of Growth

Growth is achieved by three principal mechanisms:

1. Proliferation

- **Definition**: Increase in cell number via cell division.
- **Examples**: Skin renewal, gastrointestinal epithelium turnover, tissue repair.
- **Role of Stem Cells**: Vital contributors to proliferative expansion.

2. Hypertrophy

- **Definition**: Increase in cell size.
- **Examples**:
  - Adult muscle hypertrophy due to training,
  - Cartilage cell hypertrophy during long bone development.

3. Accretion

- **Definition**: Increase in tissue size via deposition of extracellular matrix.
- **Examples**: Growth of cartilage and bone matrix.

Note: Growth is not always additive—cells may also undergo apoptosis (programmed cell death) as part of normal shaping processes.

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V. Differentiation

- **Differentiation**: The process where cells become specialized into distinct cell types (muscle cells, neurons, epithelial cells).
- **Key Points**:
  - Once differentiated, daughter cells typically retain their mature identity.
  - Experimental science aims to reprogram adult cells into stem cells for therapeutic uses.

VI. Signalling in Development

- Cells communicate via signalling molecules (e.g., proteins, hormones).
- Signals control:
  - **Migration,**
  - **Proliferation,**
  - **Differentiation.**
- **Requirement**: Recipient cells must express the correct receptors to respond.

Example:

- In the limb bud, a gradient of a morphogen determines digit formation.
- Disruption of signalling can cause duplicated or absent structures.

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VII. Organisation of Structures

- Initially, embryonic cells are arranged as simple sheets or spheres without visible organization.
- Organisation is invisible but guided by internal signalling and cell interactions.
- Example:
  - The upper limb bud becomes organized into arm, forearm, and hand based on morphogen gradients.

VIII. Morphogenesis

- **Definition**: Morphogenesis is the development of form and structure.
- Involves:
  - Changes in cell adhesion,
  - Cell migration,
  - Changes in shape and size,
  - Extracellular matrix production.
- **Example**:
  - Transformation of a flat sheet of epiblast cells into the complex tubular structures of the gut.

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IX. Clinical Relevance: Congenital Abnormalities

- **Critical Period**: The embryo is most vulnerable between weeks 3–8.
- **Teratogens**: External agents like thalidomide can cause severe deformities (e.g., phocomelia).
- **Dysmorphogenesis**:
  - **Malformation**: Intrinsic developmental errors (e.g., neural tube defects).
  - **Deformation**: External forces leading to abnormal development (e.g., amniotic bands causing limb amputations).

Summary

- Precise terminology and understanding of growth, signalling, and organization are essential to embryology.
- Development is a finely tuned orchestration of cell division, specialization, movement, and communication.
- Clinical applications highlight the importance of proper development for preventing congenital defects.