Histology of the endocrine system

• Jeanne Adiwinata Pawitan
• Dept. of Histology FMUI
Endocrine system

• Regulate metabolic activities – coordinate – integrate
  ° Organs
  ° Tissues
  ° Cells

\[\forall \approx \text{nervous system – electrochemical signal}\]

• Chemical messengers – hormones – blood \(\rightarrow\) target cells
Communication: cell - cell

• Signaling
  ° Signaling cell – signaling molecules
    • On the surface
    • Secreted – ligands – cytokines: hormones
  ° Target cell – receptor
    • On the surface – hydrophilic/polar ligand
    • Intra cell – hydrophobic/non polar ligand
      ▶ Cytosol
      ▶ nucleus
Signaling target cell

- Target cell = signaling cell: autocrine signaling
- Target – signaling cells – immediate vicinity: paracrine signaling
- Target – signaling cells – far away: endocrine signaling
Endocrine system

• Ductless gland – organ
• Cluster of cells – certain organ/tissue – pancreas, endothelium, adipose tissue, renin-angiotensin system, etc
• Endocrine cells – epithelium – certain organs
  ◦ Digestive system
  ◦ Respiratory system
Endocrine gland

- Pituitary gland (hypophysis)
- Suprarenal (adrenal) gland
- Thyroid gland
- Parathyroid gland
- Pineal body, pineal gland
Hormones ~ composition

- **Proteins & polypeptides**
  - Mostly water soluble/hydrophilic
  - Insulin, glucagon, FSH

- **Amino acid derivatives**
  - Mostly water soluble/hydrophilic
  - Thyroxine, epinephrine

- **Steroids & fatty acid derivatives**
  - Mostly lipid soluble/hydrophobic
  - Progesterone, estradiol, testosterone

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Cells of the endocrine system

- Protein/polypeptide secreting cells
  - RER >>
  - Golgi complex
  - Secretory granules
  - Other properties ≈ the cell

- Steroid secreting cells
  - SER>>>
  - Golgi complex
  - Lipid droplets
  - Other properties ≈ the cell
Pituitary gland (hypophysis)

- **Hormones:** growth, repro, metab
- **Location:**
  - Below – connected to hypothalamus – diencephalon
  - In hypophyseal fossa – in sella turcica – sphenoid bone
- **Capsule**
  - Duramater – under
  - Diaphragma sellae – upper (incomplete)
Pituitary gland (hypophysis)

- Adenohypophysis (anterior pituitary)
  - Pars distalis, pars anterior, anterior lobe
  - Pars intermedia (between pars distalis – nervosa)
  - Pars tuberalis (sleeves – around infundibular stem/stalk) – together → hypophyseal stalk/infundibular stalk

- Neurohypophysis (posterior pituitary)
  - pars nervosa - hypothalamo-hypophyseal tract
    - Median eminence of tuber cinereum
    - Infundibulum –infundibular stem/stalk
    - Pars nervosa (infundibular process, posterior lobe)
Pituitary gland – embryonic origin

• Adenohypophysis – Rathke’s pouch = evagination = oral ectoderm = lining of stomodeum (primitive oral cavity)

• Neurohypophysis – neural ectoderm = down growth of diencephalon → connected to hypothalamus – brain
  ◦ Neural pathways – hypothalamohypophyseal tract
  ◦ Rich vascular supply from the brain

→ Encapsulated – single organ
**Pituitary gland – blood supply**

- Branches of internal carotid artery
  - Superior hypophyseal arterie (1 pair)
    - Primary capillary network (plexus) – median eminence → **hypophyseal portal vein** (passing infundibulum) → secondary capillary plexus – pars distalis
    - Pars tuberalis
    - Infundibulum
  - Inferior hypophyseal arteries (1 pair)
    - Posterior lobe
    - Few branches – anterior lobe

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Pituitary gland – control of secretion

• Hypophyseal portal system – connect
  ◦ Primary capillary plexus – fenestrated
  ◦ Secondary capillary plexus – fenestrated

• Neurosecretory hormones: hypothalamus → median eminence (axons – hypothalamic neurons) → anterior lobe (pars distalis) – hormonal regulation by hypothalamus
  ◦ Releasing hormones (factors)
  ◦ Inhibiting hormones (factors)
Pituitary gland – control of secretion

- TRH = thyroid stimulating hormone (TSH) – releasing hormone
- CRH = (Adreno)corticotropin – releasing hormone
- SRH = Somatotropin (growth hormone, GH) – releasing hormone
- GnRH = Gonadotropin – releasing hormone - stimulate release of FSH, LH
- PRH = Prolactin – releasing hormone
- PIF = Prolactin inhibitory factor
Figure 13-1 Schematic diagram of the pituitary gland and its target organs. ADH, antidiuretic hormone; FSH, follicle-stimulating hormone; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.
Pars distalis, pars anterior, anterior lobe

• Fibrous capsule
• Composed of
  ° reticular fibers-surrounding
  ° Cords of cells
    • Folliculostellate cells - nonsecretory
    • Parenchymal cells
      ➢ Chromophils – affinity for dyes
        ° Acidophils (secretory granules – acid dyes)
        ° Basophils (secretory granules – basic dyes)
      ➢ Chromophobes – no affinity for dyes
  ° Large sinusoidal capillaries - fenestrated
Pars intermedia

- Colloid containing (Rathke’s) cysts
  - Lined by cuboidal cells
  - Remnants of the ectoderm of Rathke’s pouch
  - Sometimes contains basophils
    - In cords along the network of capillaries
    - Produce prohormone (proopiomelanocortin) – posttranslational cleavage $\rightarrow \alpha$ and $\beta$ MSH (melanocyte stimulating hormone) –
      - stimulate melanin production in lower animal
      - Human?
Pars tuberalis

- Frequently absent on the posterior aspect of hypophyseal stalk
- Separated from infundibulum by thin layers of pia arachnoid-like connective tissue
- Highly vascular – longitudinally oriented
  - Arteries
  - Hypophyseal portal system
- Longitudinal cords of cells: cuboidal-low columnar – basophilic – small dense granules (FSH?, LH?), lipid droplets, glycogen, occasional colloid droplets
Hypothalamohypophyseal tract

• Unmyelinated axons of neurosecretory cells
  ° Cell bodies in hypothalamus
    • Supraoptic nuclei
    • Paraventricular nuclei
  ° Synthesize
    • hormones
      ➢ Vasopressin (antidiuretic hormone, ADH)
      ➢ Oxytocin
    • Neurophysin (carrier protein – binds the hormones)
Pars nervosa (posterior lobe)

• Distal terminals of axons ← hypothalamo-hypophyseal tract
  ° LM: chrome-alumhematoxylin – Herring bodies – blue black – also along axon – contains neurosecretory granules → perivascular space

• Capillary plexus – fenestrated

• Pituicytes–glial-like supporting cells
  ° Ensheathing axons & their dilations
  ° Cytoplasmic processes – gap junctions
  ° Contains lipid droplets, some pigments & intermediate filaments
Suprarenal (adrenal gland)

• Location: superior poles of kidney – adipose tissue – retroperitoneal

• Capsule: connective tissue – many adipose tissue → septa – blood vessel, nerves

• Parenchyma
  ° Cortex – yellowish – 80-90% - mesoderm
  ° Medulla – dark – ectodermal neural crest cells
Suprarenal – blood supply

• One of the richest blood supply

• Source
  ° Inferior phrenic arteries – superior suprarenal arteries
  ° Aorta – middle suprarenal arteries
  ° Renal arteries – inferior suprarenal arteries

→ Penetrate capsule – subcapsular plexus →
  ° short cortical arteries → network-sinusoidal fenestrated capillaries → venous plexus → small venules (medula) → suprarenal vein (hilus) →
    • Inferior vena cava (right)
    • Left renal vein
  ° Long cortical arteries → medulla – capillary network
Cells - suprarenal gl

- Cortex – steroid secreting cells
  - Zona glomerulosa
  - Zona fasciculata - spongiocytes
  - Zona reticularis
- Medulla – medullary vein
  - Chromaffin cells
  - Ganglion cells
Thyroid gland

- Location: anterior – neck, inferior to larynx, ant – junction thyroid – cricoid cartilage
- Right lobe-isthmus-left lobe – (pyramidal lobe)
- Capsule: slender, dense, irregular collagenous connective tissue → septa – blood, lymph vessels, nerves → lobules
- Follicles – thin basal lamina, reticular fibers, capillary plexus
Follicles – cyst-like

- **Follicular cells** (principal cells)
  - May contact with follicular cells of other follicles w/o basal lamina

- **Parafollicular cells** (clear cells, C cells)
  - At the periphery of follicles
  - Individual/small clumps
Thyroid- follicular cell-function

**Figure 13-9** Schematic diagram of the synthesis and iodination of thyroglobulin (A) and release of thyroid hormone (B).
Parathyroid gland

• Location: posterior surface of thyroid
  ° Each pole – superior – inferior
  ° Left – right lobe of thyroid
  ° Can be else where along the pathway of descent

• Small, number 4 - /more (supernumerary)

• Capsule: thin collagenous connective tissue → septa – blood vessels, lymphatic, nerves

• Embryonic origin – pharyngeal pouches of pharyngeal/branchial arch
  ° 3rd pharyngeal pouches ≈ thymus → inferior
  ° 4th pharyngeal pouches → superior
Parathyroid gland

- Parenchyma
  - Chief cells
  - Oxyphil cells
  - (Intermediate cells)

- Reticular fibers – supporting the parenchyma

- Rich in capillary network
Pineal gland, pineal body, epiphysis cerebri

- Conical, grey body
- Location: midline of brain
  - From the roof of diencephalon
  - Shallow recess of the 3rd ventricle - extent → stalk
- Piamater → capsule → septa – blood vessels → incomplete lobules
- Parenchyma
  - Pinealocytes
  - Interstitial cells
  - Corpora arenacea (brain sand) – concretions of CaP/carbonate – concentric rings – around organic matrix
The end

Pinealocyte