MICROSCOPIC STRUCTURE, HISTOPHYSIOLOGY AND DEVELOPMENT OF ENDOCRINE GLANDS

Hormones – classification
Components of the endocrine system
Principles of humoral regulation
hormones = chemical signals used for communication between cells

more than 60 hormones classified as

- amino acids analogues and derivatives
- peptide or protein hormones
- steroid hormones

receptors are chemically defined sites bound with cell membranes

Endocrine system

- endocrine glands - hypophysis, pineal, thyroid, parathyroid, and adrenal

- endocrine cell groups located within glands with exocrine or other functions (islets of Langerhans in the pancreas, Leydig cells in testes, granulosa cells in ovaries, juxtaglomerular apparatus of kidneys, trophoblast cells of the placenta)

- cells with endocrine function that are scattered in nonglandular organs (as a gut, stomach, trachea, etc.) - e.g. GEP cells
Endocrine glands (glandulæ sine ductibus)

- have no ducts
- have exceptionally rich blood supply
- secrete hormones that pass into the circulatory system and induce a response of specific target cells, tissues, or organs

- hypophysis
- epiphysis
- thyroid gland
- parathyroid gland
- adrenal gland
- islets of Langerhans
Hypophysis (hypophysis cerebri, glandula pituitaria)

sella turcica
0.6 – 0.7 g

**adenohypophysis:**
(anterior lobe)
- pars distalis (75 %)
- pars intermedia
- pars tuberalis

**neurohypophysis:**
(posterior lobe)
- infundibulum (infundibular stem)
- pars nervosa

lobes are enveloped by a thin common connective tissue capsule, from which delicate septa with blood vessels and nerves project into the parenchyma
Blood supply: direct arterial supply has only neurohypophysis (from two sets of vessels - *superior hypophyseal arteries* and *inferior hypophyseal arteries*). The adenohypophysis is drained by hypophyseal portal veins, which arise from the primary capillary plexus in the region of the median eminence and infundibular stem.
Pars distalis is made up of cords of glandular cells among them are blood sinusoids.

**Cells:**

- chromophobie cells - 10-15%
- chromophilic cells
  - acidophilic cells - 50%
  - basophilic cells
Acidophils

somatotrophic cells

lactotrophic cells

Basophils

adrenocorticotrophic cells

thyrotrophic cells

gonadotrophic cells

gonadotrophic cells

by immunohistochemistry:
Pars intermedia consists of small cystic cavities (residua of Rathke's pouch that are limited by basophilic and chromophobie cells; basophils produce MSH - melanocyte-stimulating hormone (in amphibians) - in the human its function is unclear.
Pars tuberalis
surrounds infundibular stem, 25 – 60 μm thick, is highly vascularized and composed of clusters of basophils and chromophobic cells; basophils are supposed to secrete gonadotropic hormones (FSH, LH)

Neurohypophysis (posterior lobe)
composed of pars nervosa and infundibular stem

The pars nervosa:
- pituicytes - irregular-shaped cells with numerous processes
- axoterminals and nonmyelinized nerve fibers (whose cell bodies are in the hypothalamus (nc. supraopticus, nc. paraventricularis, nc. tuberalis)
- fenestrated capillaries

Function:
release site of hormones:
ADH (vazopresin)
oxotocin

synthetized by nerve cell bodies and are transported by axons in the infundibular stem or pars nervosa

neurosecretion

are seen at preaxoterminal sites as Herring´s bodies
Infundibular stem:
cca 100 000 neurites of nerve cells hypothalamic nuclei
(tr. hypothalamohypophysealis)

**ncl. supraopticus a ncl. paraventricularis** (large neurons)

**ncl. tuberales (nc.hypothalamicus ventromedialis et dorsomedialis, ncl. infundibularis)** - small neurons
axoterminals end near capillaries of the primary capillary plexus

**hypothalamic regulatory factors (inhibins and liberins)**

are transported via vv. portae hypophysis to the pars distalis
Development of the hypophysis

2 anlages
adenohypophysis - **ectoderm of the Rathke’s pouch**
neurohypophysis - **neuroectoderm of the ventral wall of diencephalon**

The Rathke’s pouch occurs on day 21 as tubular invagination of the roof of stomodeum growing dorsocranially against the base of diencephalon.

At the same time, base of diencephalon proliferates to form recessus infundibuli.
during the 5th week ends of both invaginations meet each other being to enclose by common connective capsule

in the course of the 6th week, Rathke’s pouch loses connection with the stomodeum, lumen rests of the pouch persist as Rathke’s cysts filled with colloid in the pars intermedia

between weeks 12-14 cells start their differentiantion

secretion of hormones begins with the end of the 4th month
Epiphysis - pineal gland (corpus pineale)

0.1 – 0.2 g
is of cone-shaped form, 5-8 x 5-5 mm

enveloped by a thin capsule with delicate septae dividing the parenchyma into lobules

They consist of two cell types:
- **pinealocytes** - which are in majority and arranged in clumps or clusters; the cells are characterized by lobulated nucleus, prominent nucleoli, and membrane-bound granules in the cytoplasm
- **interstitial cells** - about 5 % (modified astrocytes of fibrilar type) and
- **non-myelinized nerve fibres and blood capillary plexus**

Pineal gland of adults contains the calcified concretions called as brain sand or acervulus cerebri (corpora arenacea). The concretions differ from their surrounding by deep staining and concentric appearance

Hormone: **melatonin** - inhibits steroidogenic activity of endocrine cells in gonads

*Note: the tumours of the pineal are often connected with a failure of gonadal function.*
**Epiphysis**

gland develops from the roof diencephalon (epithalamus) to the end of the 1st month

in the 3rd month first pinealocytes start to differentiate
Glandula thyreoidea (thyroid gland)

25 – 40 g
in the anterior of the neck, below the cricoid cart.
2 lobes + isthmus

in 50 % of cases the pyramidal lobe (lobus pyramidalis) is found; it exits from the isthmus cranially

connective tissue capsule + septae
the parenchyma organized into the lobules

lobules are composed of the follicles, which vary considerably in diameter and contain gelatinous material called the colloid

the walls of follicles consist of simple epithelium that rests on a thin basal lamina and delicate reticular network
the epithelium involves mainly follicular cells, which are squamous to columnar in dependance on the functional status
the cells produce colloid; it consists of mucoproteins, proteolytic enzymes and a glycoprotein called thyroglobulin – primary storage form of thyroid hormone triiodothyronine (T3) + tetraiodothyronine (thyroxin, T4)
parafolicular, light or C – cells (lie immediately adjacent to basal lamina) - calcitonin
Follicles

follicular cells
parafollicular cells
**Thyroid gland**

**endodermal origin**

First anlage occurs in embryos with 16 somites on ventral wall of pharynx between the median tongue bud (tuberculum impar) and copula by proliferation of cells initially. Initially, the thyroid diverticulum originates, it is solid and rapidly grows in length, it becomes a lumen - thyroglossal duct.

Duct migrates caudally, its blind end start to proliferate and to form follicles (in the 7th week).

secretion of colloid starts during the 11th week.
rests of the thyroglossal duct: **foramen cecum** on the tongue (cranially) : **pyramidal lobe** (caudally)
chief cells

Blood capillaries

Cell cords
oxyphil cells
Parathyroid gland

superior pair of glands – from the 4th pharyngyel pouches
inferior pair of glands – from the 3rd pharyngyel pouches
Glandula suprarenalis (suprarenal gland, adrenal gland)

- Paired gland situated at upper pole of each kidney
- The right is triangular
- The left semilunar

- Weight of 5 – 7 g

- Capsule

- Cortex – 80 %

- Medulla
A schema of the adrenal gland
The adrenal cortex:

is composed of cord of glandular cells separated by blood sinusoids

according to the arrangement of cells in cords - 3 layers of the cortex are distinguished

- zona glomerulosa
- zona fasciculata
- zona reticularis
Factors acting on the gland:

**Zona glomerulosa**
- Angiotensin and corticotropin (ACTH)
- Capillaries

**Hormones secreted**
- Mineralocorticoids (aldosterone)

**Zona fasciculata**
- Corticotropin

**Hormones secreted**
- Glucocorticoids (cortisol and corticosterone)
- Androgens? (dihydroepiandrosterone; androstenedione)

**Zona reticularis**
- Corticotropin

**Hormones secreted**
- Glucocorticoids?
- Androgens
The adrenal medulla

composed of large round or polyhedral cells arranged in clumps or short cords surrounded with framework of reticular fibers, containing numerous capillaries with fenestrae, venules, nerve fibers and solitary sympathetic neurones

glandular cells called as chromaffin cells contain fine granular cytoplasm and secrete catecholamines

2 types of chromaffin cells:
- secreting adrenalin or epinephrine (most - 96%)
- secreting noradrenalin or norepinephrine (the rest)
Blood supply of the adrenal gland
Adrenal gland

its development begins during the 5th week

cortex - **coelomic mesoderm**

medulla - **crista neuralis**

zona glomerulosa and fasciculata are developed at birth

zona reticularis occurs around the 3rd postnatal year
Endocrine glands - summary

hypophysis: adenohypophysis - **ectoderm of the stomodeum**
neurohypophysis - **neuroectoderm of the diencephalon (base)**

epiphysis - **neuroectoderm of the diencephalon (roof)**

thyroid gland - **endoderm of the primitive pharynx**

parathyroid glands - **endoderm of pharyngeal pouches (3rd, 4th)**

adrenal gland: cortex - **coelomic mesoderm**
medulla - **neural crest (crista neuralis)**

Langerhans islets - **endoderm of the foregut (duodenum)**