BGD Lecture - Endocrine Histology

From Embryology

Introduction

This lecture introduces Endocrine Histology, particularly of the HPA axis, that will also be covered in an associated practical class. A second Lecture next week will describe how these organs form during development.

Interested in hormone history? Listen ABC Radio Ockham's Razor 2005-07-31 - Centenary of the word "hormone" Sydney medical scientist and writer Dr John Carmody commemorates the centenary of the entry of the word 'hormone' into the English language. Audio File | Listen Online

Textbooks


Chapter 7. The pituitary gland (http://www.ncbi.nlm.nih.gov/books/n/endocrin/A1257/)

- Anatomical and functional connections of the hypothalamo-pituitary axis
  (http://www.ncbi.nlm.nih.gov/books/n/endocrin/A1257/#A1267)
  - Box 7.3 Anatomy of the functional connections between the hypothalamus and pituitary gland
    (http://www.ncbi.nlm.nih.gov/books/NBK27/box/A1269)
  - Box 7.4 Hormone secretions of the anterior lobe of the pituitary gland and their control
    (http://www.ncbi.nlm.nih.gov/books/NBK27/box/A1270)
  - Box 7.5 Diagram of the anatomy of the hypothalamo-pituitary axis showing the major
    hypothalamic nuclei (http://www.ncbi.nlm.nih.gov/books/NBK27/box/A1272)

- Blood supply of the hypothalamo-pituitary axis
  (http://www.ncbi.nlm.nih.gov/books/n/endocrin/A1257/#A1297)
  - Box 7.8 Diagrammatic representation of the blood supply and venous drainage of the median
    eminence and pituitary gland (http://www.ncbi.nlm.nih.gov/books/NBK27/box/A1298)

Chapter 4. The adrenal gland (http://www.ncbi.nlm.nih.gov/books/n/endocrin/A442/)

- Specificity of the biological effects of adrenal steroid hormones
Endocrine feedback system

- Cholesterol and steroid synthesis in the adrenal cortex
- Anatomical and functional zonation in the adrenal cortex
- Box 4.6 Histology and blood supply of the adrenal gland
- Box 4.39 Biosynthesis and control of catecholamines secreted by the adrenal medulla
- Hypothalamic control of adrenocortical steroid synthesis - CRH and vasopressin
- Pituitary control of adrenocortical steroids - ACTH
- Box 4.14 Control of cortisol and androgens from the adrenal cortex
- Feedback control of glucocorticoids

Histology on Notes Pages: Pineal | Hypothalamus | Pituitary | Thyroid | Parathyroid | Thymus | Pancreas | Adrenal

Pituitary Histology: Anterior H&E | Anterior labeled | PAS/O Overview | Acidophils | Basophils | Posterior labeled | Posterior unlabeled | Histology Stains | BGD - Endocrine Histology | Pituitary Development

Adrenal Histology: Cortex and Medulla | Unlabelled Overview | Cortical Zones | Zona Glomerulosa and Fasciculata | Zona Glomerulosa | Zona Fasciculata | Zona Reticularis and Medulla | Zona Reticularis | Medulla | Fetal Cortex | Developing Adult Cortex | BGD - Endocrine Histology | Histology Stains | Adrenal Development

Hormones

Hormone Types
- Amino acid derivatives - noradrenaline (norepinephrine), adrenalin (epinephrine), thyroid hormone
- Proteins, peptides - thyroid stimulating hormone, leutenising hormone, follicle stimulating hormone
- Steroids - androgens, glucocorticoids, mineralocorticoids

Hormone Actions
- Autocrine - acts on self (extracellular fluid)
- Paracrine - acts locally (extracellular fluid)
- Endocrine - acts by secretion into blood stream (endocrine organs are richly vascularized)

Hormone Receptors
- Cell surface receptors - modified amino acids, peptides, proteins
- Cytoplasmic/Nuclear Receptors - steroids

Hypothalamic Pituitary Adrenal (HPA) Axis

1. The hypothalamus secretes releasing hormone (CRH) that act on the pituitary gland.
2. In response to this stimuli, the pituitary gland releases ACTH.
3. ACTH activates the adrenal glands to release cortisol, which induces metabolic effects.
4. Cortisol also acts back on the hypothalamus and pituitary gland by negative feedback.

**Other Endocrine Axes**

- Hypothalamus - Pituitary - Thyroid
- Hypothalamus - Pituitary - Gonad (female)
- Hypothalamus - Pituitary - Gonad (male)

**Hypothalamus**

- essential for the maintenance of homeostasis.
- regulation of eating, drinking, reproductive and parental behavior, and sleep-wake rhythms.
- controls the autonomic nervous system and hormone secretion.
- rostral-caudal axis - preoptic, anterior, tuberal and mammillary.
- medial-lateral axis - periventricular, medial and lateral zones.

**Diencephalon**

**Pituitary**
Neurohypophysis

sits within a cavity in the skull-base, the "sella turcica" (Turkish saddle), named historically by its similarity in shape.

2 embryonic origins.
(phil= likes, phob = hates)

**Blood supply**

- hypothalamus - blood supply from the circle of Willis.
- pituitary - blood from the inferior (neurohypophysis) and superior (adenohypophysis) hypophyseal arteries.
  - inferior hypophyseal artery capillary plexus drains into the dural sinus.
  - neural stalk some capillaries form about 20+ "short" portal veins that drain into the anterior pituitary gland.
- hypophyseal vein then drains into systemic venous blood.

**Links:** Box 7.8 Diagrammatic representation of the blood supply and venous drainage of the median eminence and pituitary gland (http://www.ncbi.nlm.nih.gov/books/NBK27/box/A1298)

**Pituitary - Neurohypophysis**

- posterior pituitary
- cells are pituicytes and also present are hypothalamic neurosecretory cell unmyelinated nerve fibres (from the supraoptic and paraventricular nuclei).
- pituicyte oval or round nuclei are visible.
- **Herring bodies** are dilations of nerve fibres filled with small neurosecretory vesicles.
  - nerve fibres terminate close to capillaries.
- hormones are releasing and release-inhibiting factors produced regulating adenohypophysis activity (as well as 2 other 9 aa hormones).
  - Oxytocin - pregnancy stimulates uterine smooth muscle the contraction and lactation milk ejection reflex.
  - Antidiuretic hormone - (ADH, vasopressin, arginine vasopressin, AVP) acts on kidneys to concentrate urine (water retention).

**Pituitary - Adenohypophysis**

- anterior pituitary - 3 parts pars distalis, pars tuberalis and pars intermedia.
- pars distalis of the adenohypophysis occupies about 75% of the hypophyseal tissue.
- stromal connective tissue - very little visible.
- parenchymal endocrine cells - arranged in irregular clumps or cords between a network of capillaries with large and irregular lumina.
- hormones are proteins or glycoproteins.
- H&E staining identifies 3 cell types:
1. acidophil cells (acidophils)
2. basophil cells (basophils)
3. chromophobe cells

Acidophil cells
- about 65% of all cells.
- rounded and smaller than basophil cells (other stains identify subtypes).
- Somatotrophs - produce growth hormone (GH or somatotropin), stimulates liver cells to produce polypeptide growth factors which stimulate growth (stain with orange G)
- Mammotrophs - (lactotrophs) produce prolactin, maternal numbers increase in third trimester and postnatally in early lactation.

Basophil cells
Based on their hormone products basophils are divided into three subtypes (PAS stain all types reddish).
- Thyrotrophs - produce thyroid stimulating hormone (TSH or thyrotropin).
- Gonadotrophs - produce follicle stimulating hormone (FSH) and luteinizing hormone (LH)
  - FSH stimulates in the male seminiferous tubule and female early follicular growth.
  - LH stimulates male Leydig cell testosterone production and female oestrogen (estrogen) production, late follicular maturation, formation of corpus luteum.
- Corticotrophs - (or adrenocorticotrophs) produce adrenocorticotrophic hormone (ACTH or corticotropin) and lipotropin (LPH).
  - cell type in the pars intermedia where ACTH and LPH precursor undergoes hydrolysis into melanocyte stimulating hormone (MSH) and other peptides.

Chromophobe cells
- cells are unstained or weakly stained cells.
- either acidophils or basophils in a dormant or recently degranulated stage.
- may also include the secretory stem cells.

Adrenal
Cortex zones
- adrenal gland, suprarenal gland
- paired lying above kidneys
- surrounded by a thick connective tissue capsule.
  - vessels and nerves reach the medulla through connective tissue trabeculae
- outer cortex (about 90%) and inner medulla (about 10%).
  - each has different embryonic origins.

Adrenal Cortex
- divided into three zones (Adrenocorticotropic hormone (ACTH) required for zones 2 and 3)
  1. zona glomerulosa (about 15%)
  2. zona fasciculata (about 75%)
  3. zone reticularis is (about 10%)

Zona Glomerulosa
- Small cells arranged into small rounded groups or curved columns.
- not influenced by ACTH.

Zona Fasciculata
- cell cords arranged radially arranged cell cords separated by fenestrated sinusoid capillaries.
- cell nucleus is light and centrally located.
- cell cytoplasm is also light and often "foamy" or "spongy" appearance (due to lipid droplets)

Zona Reticularis
- cell chords separated by sinusoid spaces.
- small cells with large nucleus, and eosinophilic cytoplasm and less spongy. (lipofuscins accumulates with age, orange colour in H&E).
Adrenal Medulla
Zona Glomerulosa and Fasciculata

- cells arranged in strands or small clusters with capillaries and venules in the intervening spaces.
- cell cytoplasm weakly basophilic.
  - chromaffin cells because granules can be stained with potassium bichromate.
- innervated by preganglionic sympathetic fibres.
- 2 indistinguishable cell types, neural crest in origin.

1. Adrenaline producing cells - epinephrine (80%)
2. Noradrenaline producing cells - norepinephrine (20%)

Histology Images

Pituitary

- Posterior labeled
- Posterior unlabelled
- Anterior H&E
- Anterior H&E
**Anterior labeled**  
PAS/O Overview  
Acidophils  
Basophils

**Pituitary Histology:** Anterior H&E | Anterior H&E | Anterior labeled | PAS/O Overview | Acidophils | Basophils | Posterior labeled | Posterior unlabeled | Histology Stains | BGD - Endocrine Histology | Pituitary Development

**Adrenal**

Cortex and Medulla  
Unlabelled Overview  
Cortical Zones  
Zona Glomerulosa and Fasciculata

Zona Glomerulosa  
Zona Fasciculata  
Zona Reticularis and Medulla  
Zona Reticularis

Medulla  
Fetal Cortex  
Developing Adult Cortex

**Adrenal Histology:** Cortex and Medulla | Unlabelled Overview | Cortical Zones | Zona Glomerulosa and Fasciculata