Endocrine Notes

Mrs. Laux AP Biology

I. Endocrine System

→consists of endocrine glands (ductless), cells, tissues

→secrete hormones

→regulates metabolism, fluid balance, growth, reproduction

A. Hormones

1. chemical signals-cell to cell communication

2. classical definition

a. secreted into blood or interstitial fluid by endocrine glands

b. transported by blood

c. bind to receptors on target tissues

3. other cells, tissues, organs secrete

a. hormones and hormone-like substances

b. ex: growth factors

i. peptides-stimulate cell division and development

c. transported in axons or ISF

4. Neuroendocrine cells secrete

a. neurohormones-transported down axons, secreted, transported by blood

5. Paracrine regulation

a. hormone or other signal molecule

b. diffuses through ISF

c. acts on nearby target cells

d. Prostaglandins

i. group of local hormones

ii. help regulate many metabolic processes by paracrine signaling

6. Autocrine regulation

a. hormone or other signal molecule

b. secreted in ISF

c. acts back on the very cell that produced it

B. Hormones-4 chemical groups

1. Fatty acid derivatives

a. prostaglandins, juvenile hormones of insects

2. Steroids

a. secreted by adrenal cortex, ovaries, testes

b. molting hormone (ecdysone) of insects

c. hydrophobic-pass through membrane, combine with receptors within target cell

d. hormone-receptor complex may activate or repress transcription of mRNA coding for specific proteins

3. Amino acid derivatives

a. thyroid hormones, epinephrine

b. hydrophobic-pass through membrane, combine with receptors within target cell

c. hormone-receptor complex may activate or repress transcription of mRNA coding for specific proteins

4. Peptides or proteins
a. ADH, glucagon (peptide hormones)
b. insulin (small protein)

C. Hormone Regulation
1. negative feedback

D. Receptors on or in target cells
1. hormones can stimulate synthesis of their own receptors; thus amplifying their effect on the cell
a. receptor-up regulation
2. hormones can decrease the number of their own receptors; thereby suppressing the sensitivity of target cells to the hormone
a. receptor-down regulation
3. steroids and thyroid hormones-hydrophobic
4. most hormones hydrophilic-do not enter target cell
a. combine with receptor on plasma membrane
b. act via signal transduction
i. extracellular hormone signal transduced by receptor into intracellular signal
c. peptide hormones-first messengers
i. carry out actions by way of second messengers
a. ex: cyclic AMP (cAMP) or Ca ions
ii. hormone-receptor complex activates a coupling molecule, typically a G protein
a. either stimulates or inhibits an enzyme that affects second messenger, like adenylyl cyclase
i. catalyzes conversion of ATP to cAMP
ii. most second messengers stimulate the activity of protein kinases
d. most protein kinases phosphorylate specific proteins that affect the activity of the cell
5. certain hormone-receptor complexes increase the concentration of Ca ions in the cell
a. Ca ions bind with calmodulin, activates certain enzymes
6. Inositol triphosphate (IP3) and diacylglycerol (DAG)
a. are second messengers
b. increase Ca concentration and activate enzymes
7. Signal amplification occurs as:
a. each hormone-receptor complex stimulates the production of many second messenger molecules
b. second messengers in turn activate protein kinase molecules that can activate many protein molecules

II. Invertebrate hormones
→secreted by neurons
→help regulate regeneration, molting, metamorphosis, reproduction , metabolism
A. pigment distribution in crustaceans is regulated by neurohormones

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B. Hormones control development in insects

1. brain hormone→ molting hormone (ecdysone)

2. juvenile hormone

a. suppresses metamorphosis at each larval molt

b. decreases with successive molts

III. Vertebrate hormones

→regulate growth, reproduction, salt and fluid balance, many aspects of metabolism

→nervous and endocrine integrated in hypothalamus→regulates activity of pituitary gland

→hyposecretions-abnormally reduced output of hormones

→hypersecretions-abnormally increased output of hormones

A. Neurohormones-produced by hypothalamus, released by posterior lobe of pituitary

1. Oxytocin

a. stimulates contraction of uterus

b. stimulates ejection of milk by mammary glands

2. ADH (antidiuretic hormone)

a. stimulates reabsorption of water by the kidney tubules

B. Hormones secreted by anterior lobe of pituitary

→regulated by releasing hormones and inhibiting hormones, secreted by hypothalamus

1. Growth hormone

a. anabolic-stimulates body growth by promoting protein synthesis

b. stimulates liver to produce somatomedins (insulin-like growth factors)

i. promote skeletal growth, general tissue growth

c. malfunctions

i. pituitary dwarfism-small stature

ii. gigantism-large stature

iii. acromegaly-"large extremities"-hands, feet, face bones continue to increase in diameter after long bones have stopped growing

2. Prolactin

a. stimulates mammary glands to produce milk (moo juice)

3. Tropic hormones

a. stimulate other endocrine glands

b. ex: ACTH-adrenocorticotropic hormone

i. regulates glucocorticoids and aldosterone secretions

ii. very potent

C. Other hormones and their glands

1. Thyroid gland secretes

a. thyroid hormones

i. thyroxine or T4

ii. triiodothyronine or T3

- **iii. stimulate the rate of metabolism**
- **b. secretion depends on negative feedback between anterior pituitary (TSH-thyroid stimulating hormone) and thyroid**
- **c. hypo-**
  - **i. during childhood-cretinism-retarded mental and physical development**
  - **ii. during adulthood-myxedema-slowing down of physical and mental activity**
- **d. hypo and hyper-goiter**
  - **i. enlargement of thyroid gland in neck**
  - **ii. with Grave's or with iodine deficiency**
- **e. hyper-Grave's disease-autoimmune**
  - **i. abnormal antibodies bind to TSH receptors and activate them**

2. Parathyroid-parathyroid hormone or parathormone
- **a. regulates blood Ca level**
- **b. increases Ca level by stimulating release of Ca from bones, increasing Ca reabsorption in kidney tubules, increasing Ca reabsorption in intestine**

3. Calcitonin from thyroid gland
- **a. acts antagonistically to parathormone**

4. Islets of Langerhans in pancreas secrete
- **a. insulin-beta cells**
  - **i. stimulates cell to take up glucose from the blood**
  - **ii. lowers blood sugar levels**
- **b. glucagon-alpha cells**
  - **i. raises blood sugar levels**
  - **ii. stimulates conversion of glycogen to glucose (glycogenolysis) and production of glucose from other nutrients (gluconeogenesis)**
- **c. both regulated by blood glucose levels**
- **d. diabetes mellitus**
  - **i. insulin deficiency or**
  - **ii. insulin resistance**
  - **iii. result: decreased utilization of glucose, increased fat mobilization, increased protein utilization**

5. Adrenal glands-help body cope with stress
- **a. Adrenal medulla**
  - **i. secretes epinephrine- (adrenaline) and norepinephrine noradrenaline)-belong to chemical group called catecholamines**
  - **a. help body respond to stress by**
    - **i. increasing heart rate, metabolic rate, muscle contraction**
    - **ii. reroute blood to organs needed for fight of flight**

b. secretions controlled by sympathetic nerves

b. Adrenal cortex secretes
i. sex hormones
a. testosterone
b. estradiol
ii. mineralcorticoids-aldosterone
a. increases rate of Na reabsorption, K excretion by kidneys
iii. glucocorticoids- cortisol (hydrocortisone)
a. promotes gluconeogenesis
b. hyper-Cushing's disease
i. fat deposited around trunk
ii. moon face appearance due to edema
iii. blood-glucose-50% above normal
iv. pancreas burns out-beta cells
iv. ensures adequate fuel supplies for rapidly metabolizing cells
v. destruction of adrenal cortex causes Addison's disease
a. body loses ability to cope with stress
b. prevents regulation of blood glucose concentrations

6. Pineal gland-melatonin
a. influences biological rhythms
b. onset of sexual maturity
c. in humans-facilitates the onset of sleep
d. exposure to light suppresses secretion of melatonin
i. blind girls-early periods

7. Thymus-thymosin
a. plays a role in immune response

8. Atrial natriuretic factor (ANF)
a. secreted by atrium
b. promotes Na excretion, lowers blood pressure

9. Digestive tract hormones
a. regulate digestive processes

III. Pheromones
→chemical messenger
→produced by animals for communication with other animals of same species
→produced by exocrine glands, not true hormones
→will see more in Chap. 50, Animal Behavior