Endocrine system (chapter 18)

• Overview and contrast with nervous system
• General concepts
  – what controls secretion
  – how do they act
• Specific examples of important endocrine systems

Hormones

• Classical definition: chemical secreted by endocrine gland, circulated in blood, affects target cells through interaction with cellular receptors.
• Endocrine vs. exocrine gland (Fig 18.1)
• Hormone vs. paracrine & autocrine factors (Fig 18.2)

Distinction between neural and hormonal control is weak - both involve cell-cell communication
• Neural - neurotransmitters and nerve cells are “hardwired”, act quickly, turn on and off quickly
• Hormonal - hormones circulate everywhere, have effects that may last minutes to days
• Where would endocrine control be useful vs. nervous control?

Endocrine coordination/integration

• Sodium and water balance (protect cell volume and pressure)
• Calcium balance (membrane function, intracellular signaling, clotting, skeletal function)
• Energy balance
  – Maintain glucose for CNS function
  – Gut function
  – Store excess in times of plenty (insulin)
  – Access stores in times of need/inter-convert fuels

• Cope with “hostile” environment
  – Temperature regulation (thyroid hormones)
  – Stress response
  – Behavioral response (e.g. defend territory/mate/family)
• Growth and development
  – Male/female differences (sex steroids)
  – Growth hormone and growth factors
• Reproduction and lactation
  – Many hormones
• MULTIPLE HORMONES usually involved in all above categories
Homeostasis depends on reflexes (feedback loops)

1. Pure nervous reflex (withdrawal reflex)
2. Pure classical endocrine reflex (Fig 18.19)
   - high blood glucose → insulin → lowers BG
   - low BG → glucagon → increases BG
3. Neuroendocrine Reflex (Fig 18.9 & 10)
   - suckling or birthing events → oxytocin release
   - high osmotic pressure → antidiuretic hormone
4. Endocrine and Nervous reflexes (reinforcement)
   - SNS → decreased insulin, PSNS → increased I
5. Neuroendocrine/endocrine reflex (Fig 18.5 & 7)
   - Hypothalamus releases Growth hormone
     - Releasing Hormone, portal vessels to anterior pituitary, release Growth Hormone
6. Neurosecretion and TWO sequential hormones (typical of most anterior pituitary hormones (Fig 18.6)
   - CRH → ACTH → adrenal cortex (cortisol)
   - BRAIN tends to be major integrating center (especially hypothalamus)

Control of hormone secretion

- Negative feedback (see 18.6)
  - Relatively constant cortisol
  - Override possible
    - Circadian adjustments (higher in early morning)
    - Stress release
- Rarely see positive feedback
  - Cervical stretch → oxytocin from p. pituitary → great uterine contraction and cervical stretch → more oxytocin

What governs magnitude of hormone response?

- Secretion rate
- Excretion/degradation of hormone (1/2 life may be minutes to hours)
- Amount of binding protein in blood
- # or target cells (e.g. tyroidectomy to treat too much pituitary thyrotropin (Fig 18.12)

Response, cont.

- # of cell receptors
  - Up regulation
  - Down regulation
- “Down-stream events in hormone signal transduction
  - Type II diabetes (insulin resistance)
  - Early stages, insulin often high, but cells can’t respond

Hormones seldom act alone

- Synergism
  - Cortisol, glucagon and epinephrine all elevate blood glucose
  - Additive response greater than individual responses
- Permissive
  - Thyroid hormone necessary for growth
- Push-pull dual control
  - Increase glucagon, decrease insulin to elevate blood glucose