

Chapter 41 Chemical Regulation

Regulation

- Why are hormones needed?
 - ♦ chemical messages from one body part to another
 - ♦ communication needed to coordinate whole body
 - ♦ homeostasis & regulation
 - metabolism
 - growth
 - development
 - maturation
 - reproduction

growth hormones

Regulation & Communication

- Animals rely on 2 systems for regulation...
 - ♦ **endocrine system**
 - system of ductless glands
 - ♦ secrete chemical signals 'directly' into blood
 - ♦ chemical travels to target tissue
 - ♦ slow, long-lasting response
 - ♦ **nervous system**
 - system of neurons
 - ♦ transmits "electrical" signal & release neurotransmitters to target tissue
 - ♦ fast, short-lasting response

Regulation by Chemicals

- **Neurotransmitters** released by neurons
- **Hormones** release by endocrine glands

Homology in Hormones

What does this tell you about these hormones?

How could this hormone have different effects?

prolactin				growth hormone
mammals	birds	fish	amphibians	
milk production	fat metabolism	salt & water balance	metamorphosis & maturation	growth & development

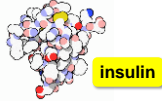
Osmotic water gain through gills and other parts of body surface.
 Uptake of water and some ions in food.
 Uptake of salt ions by gills.
 Excretion of large amounts of water to dilute urine from kidneys.

Types of Hormones

- **circulating hormones**
 - ♦ hormones that diffuse into the blood to activate target cells far away
- **local hormones**
 - ♦ hormones that affect target cells close to their release site
 - **autocrine**: hormone-releasing cell affected
 - **paracrine**: hormone affects nearby cells only

Classes of Hormones

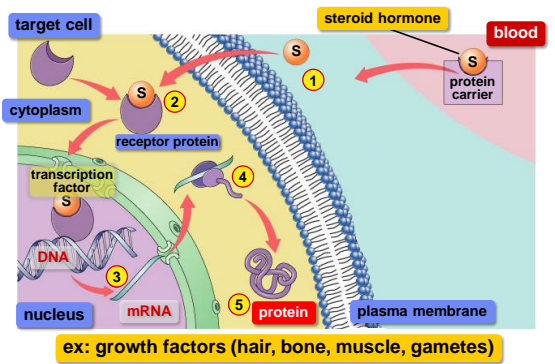
- **Lipid-based hormones**
 - ♦ steroids
 - modified cholesterol: sex hormones, aldosterone
- **Protein-based hormones**
 - ♦ polypeptides
 - small proteins: insulin, ADH
 - ♦ glycoproteins
 - large proteins + carbohydrate: FSH, LH
 - ♦ amines
 - modified amino acids: epinephrine, melatonin



How do hormones act on target cells?

- **Lipid-based hormones**
 - ♦ hydrophobic & lipid-soluble
 - diffuse across membrane & enter cells
 - bind to receptor proteins in cytoplasm & nucleus
 - bind to DNA as transcription factors
- **Protein-based hormones**
 - ♦ hydrophilic & not lipid soluble
 - can't diffuse across membrane
 - receptor proteins in cell membrane
 - trigger secondary messenger pathway
 - activate internal cellular response
 - ♦ enzyme action, uptake or secretion of molecules...

Action of Lipid (Steroid) Hormones

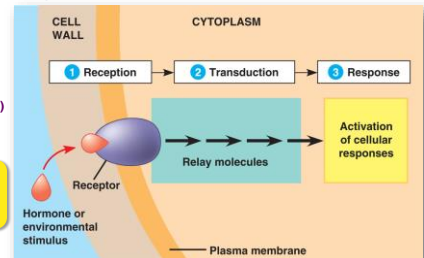


Signal Transduction Pathway

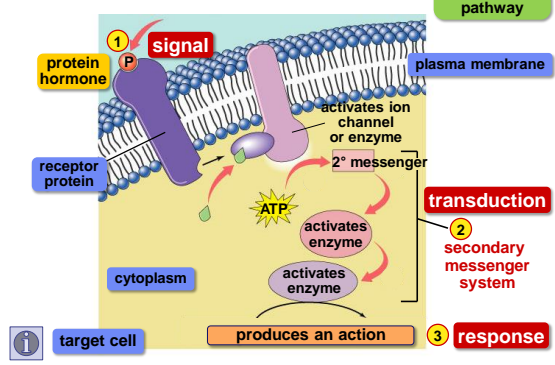
- signal triggers receptor
- receptor triggers internal cellular messengers & then cellular response

- receptor
- signal pathway (2^o messengers)
- response

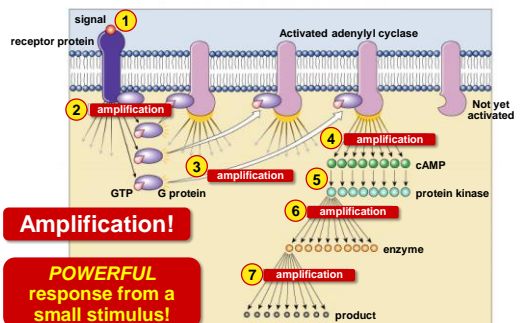
What kinds of molecules are the receptors?



Action of Protein Hormones

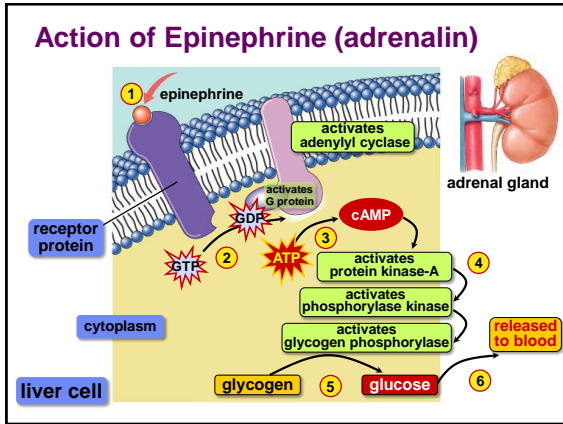


Benefits of a 2^o Messenger System



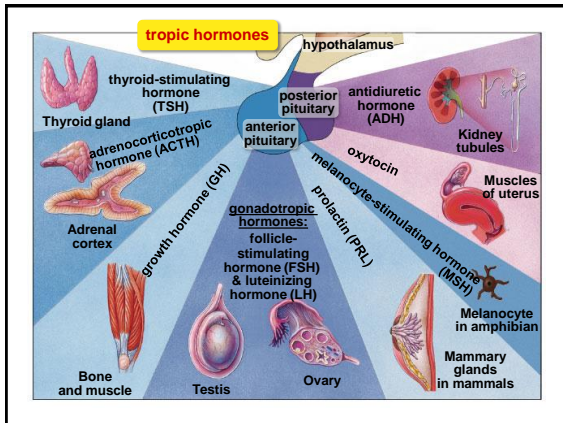
Amplification!

POWERFUL response from a small stimulus!



Nervous & Endocrine Systems Linked

- Hypothalamus** = “master nerve control center”
 - nervous system
 - receives information from nerves around body about internal conditions
 - regulates release of hormones from pituitary
- Pituitary gland** = “master gland”
 - endocrine system
 - secretes broad range of hormones regulating other glands

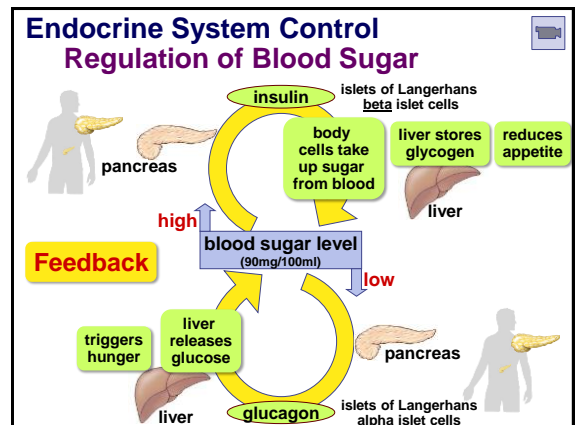


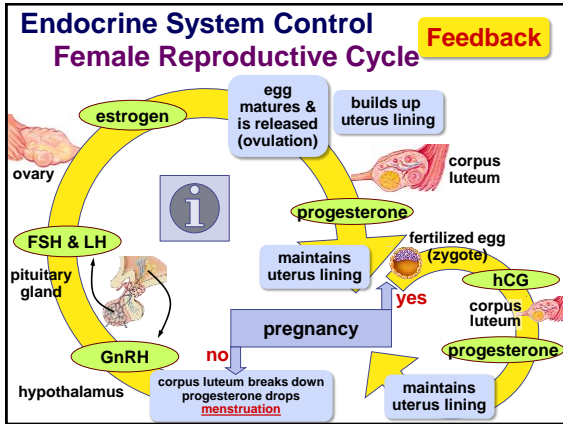
Regulating Metabolism

- Hypothalamus**
 - TRH = TSH-releasing hormone
- Anterior Pituitary**
 - TSH = thyroid stimulating hormone
- Thyroid**
 - produces thyroxine hormones
 - metabolism & development
 - bone growth
 - mental development
 - metabolic use of energy
 - blood pressure & heart rate
 - muscle tone
 - digestion
 - reproduction

Managing Glucose Levels

- Mammals regulate use & storage of glucose**
 - insulin** reduces blood glucose levels
 - glucose levels rise above set point, pancreas secretes insulin
 - promotes transport of glucose into cells & storage of glucose (as glycogen) in liver & muscle cells
 - drops blood glucose levels
 - glucagon** increases blood glucose levels
 - when glucose levels drop below set point, pancreas secretes glucagon
 - promotes breakdown of glycogen & release of glucose into the blood
 - raises blood glucose levels





Regulation of Blood Volume / Pressure

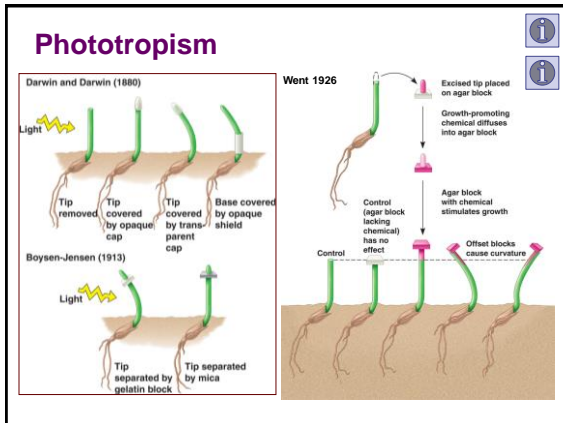
- Hormone regulation**
 - ADH (antidiuretic hormone)**
 - from pituitary
 - causes kidneys to reabsorb more water

↑ BP
 - aldosterone**
 - from adrenal gland
 - causes kidneys to reabsorb Na⁺

↑ BP
 - atrial natriuretic hormone**
 - from heart (right atrium)
 - promotes excretion of Na⁺ in urine

↓ BP
 - nitric oxide**
 - from blood vessel cells
 - dilates blood vessels
 - nitroglycerin & Viagra release nitric oxide

↓ BP



Phytochrome Photoreceptors

- Molecular switch reaction to red light**
 - conversion of P_r → P_{fr} in sunlight stimulates germination, flowering, branching...
 - conversion of P_{fr} → P_r in dark inhibits response, & stimulates other responses: growth in height

Chromophore
Synthesis →
Kinase activity
Response: Vertical growth
Phytochrome
Phytochrome
Enzymatic destruction
Red light
Far-red light
Light induced Responses: seed germination, control of flowering, etc.

Flowering Response

- Triggered by photoperiod**
 - relative lengths of day & night
 - night length—"critical period"—is trigger

Synchronizes plant responses to season!

24 hours
Darkness
Flash of light
Critical dark period
Light
Short-day plants
Long-day plants
Plant is sensitive to red light exposure!

