Brain Resource Creation Workshop:
Chapter 10 - The Body in Balance

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The Body in Balance

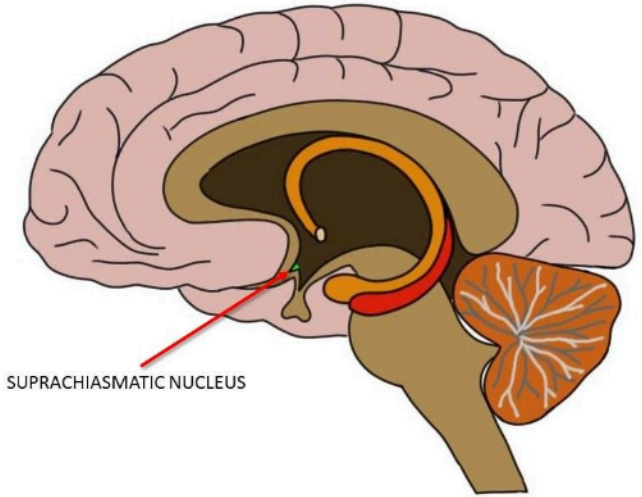
Homeostasis:

- Maintaining balance & equilibrium in body's tissues/organ systems
- Active regulation helps maintain sufficient environment for cells
- Brain is a part of systems
  - Sent signals that manage internal clocks of the body
  - Regulates hormone secretion in endocrine system
- Involves hypothalamus: region of forebrain

Circadian rhythms

Suprachiasmatic nucleus (SCN):

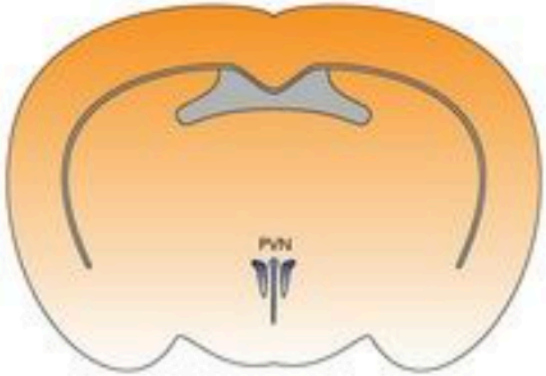
- Tiny group of neurons in hypothalamus
- Coordinates daily rhythms
- Emits action potentials during day, becomes quiet during the night
  - Controlled by "clock genes"
- Tracks time of day based on
  - Signals from photoreceptors in retina
  - Helps keep activity in sync with the true day and night cycles



Circadian rhythms

Paraventricular nucleus (PVN):

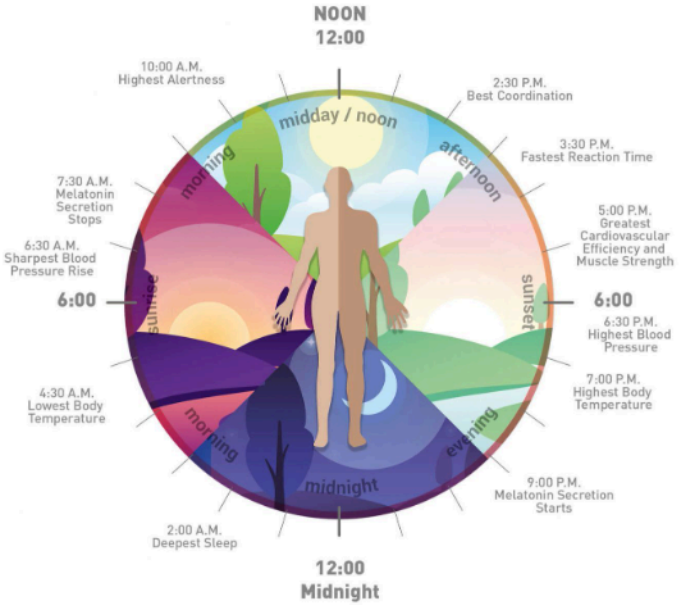
- When stimulated by neurons in SCN, this sends signals through...
  - Spinal cord to peripheral regions of body
- Some pathways can control melatonin, which impacts sleep
- Electrical activity can enter PVN
  - Sends signals to pineal gland, embedded between cerebral hemispheres



Circadian rhythms

Synchronization/Desynchronization:

- Synchronized body clocks are coordinated in 24 hour day cycle
  - After waking up, cortisol peak in the blood and release sugars to increase hunger
  - Metabolic rate increases as body temp increases
- Jet lag = desynchronization
  - Happens during circadian rhythm disturbances (ex: crossing many time zones in a short period)
  - Long term effects could be weight gain, insomnia, depression, etc.



Hormones, Homeostasis, and Behavior

Neuroendocrine system:

- Brain regions involved in the releasing of hormones
- Brain listens to hormonal signals
  - Neurons have hormone receptors throughout the brain
- Changes body's behaviors to maintain equilibrium

Hormones, Homeostasis, and Behavior

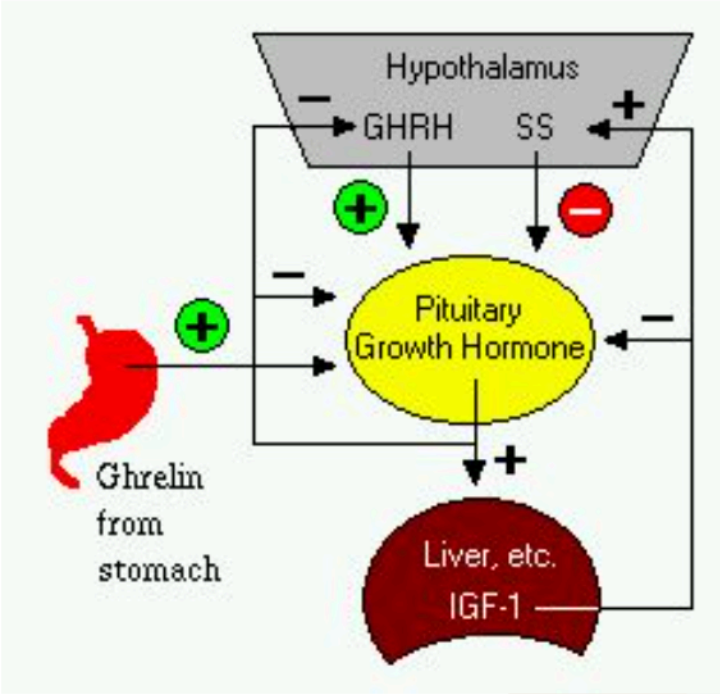
Hypothalamus:

- Tied to the pituitary gland, helping it regulate hormone production/release
- Axons are sent into posterior part of pituitary gland
- Oxytocin or vasopressin is released when neurons are activated
  - Molecules act as neurotransmitters
- Oxycontin: for uterine contractions
- Vasopressin: amplifies water retention

Hormones, Homeostasis, and Behavior

Release of hormones:

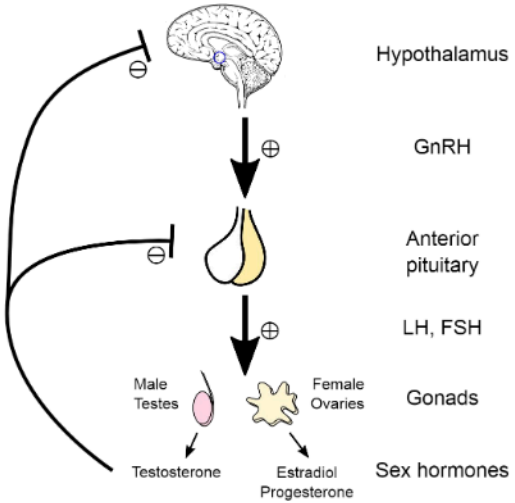
- Hormones produced by pituitary & endocrine glands affect brain receptors
  - Alters gene transcription/neuron functions
  - Reduces hormone released by hypothalamus
- Negative feedback loop allows for hormone delivery to body tissues



Hormones, Homeostasis, and Behavior

Male sex hormones:

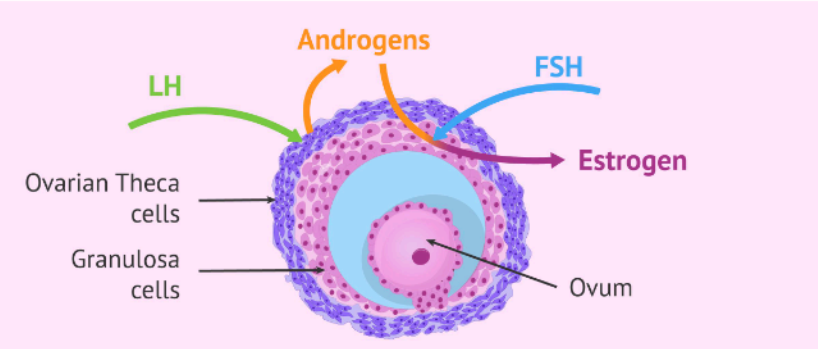
- Negative feedback loops that reduce hormone secretion
  - Especially of gonadotropin-releasing hormone, luteinizing hormone, and follicle stimulating hormone
- Creates pulse of GnRH that peaks every 90 minutes
- GnRH levels help balance testosterone levels and allows testes to produce sperm every day



Hormones, Homeostasis, and Behavior

Female sex hormones:

- When there is low level of estrogen and progesterone...
  - Egg maturation and estrogen production is stimulated
- Negative feedback on FSH secretion is stimulated
  - Limits number of eggs that mature
- Positive feedback on LH stimulated
  - Triggers ovulation
- Ovarian activity is eventually reduced after ovulation



Hormones, Homeostasis, and Behavior

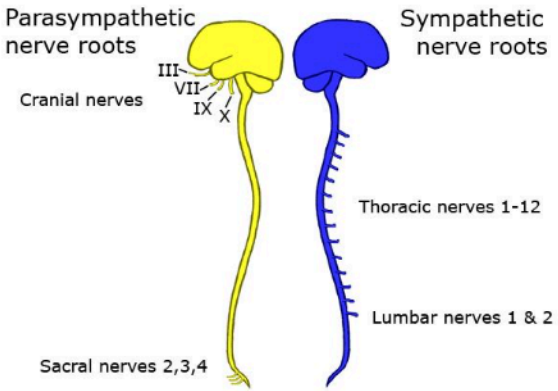
Leptin and ghrelin:

- Regulates food intake and energy balance
- Released when internal energy stores are changed
- Ghrelin: activates hunger circuits in hypothalamus that drive hunger
- Leptin: suppresses hunger circuit activity and reduces eating desire
    - As fat stores are used, leptin levels decrease

The Stress Response

Flight or fight response:

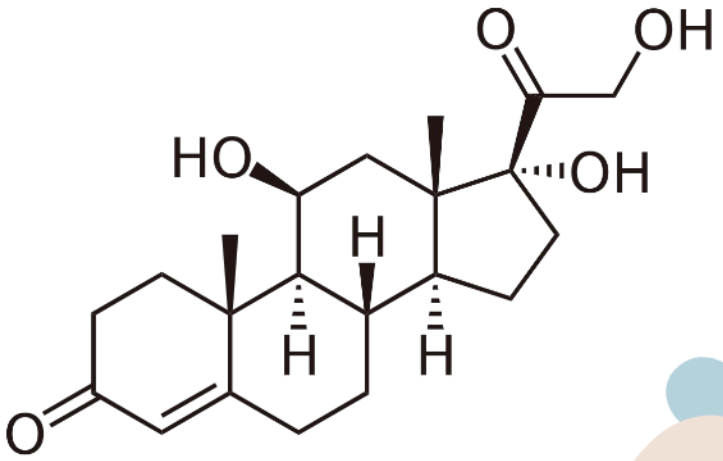
- Messages sent to somatic nervous system
  - Signals the body to run from danger
- Messages sent to autonomic nervous system
  - Redirects nutrients & oxygen to the cells
- Sympathetic branch: tells adrenal medulla to release epinephrine
  - Heart pumps blood faster so muscles respond quickly
- Parasympathetic branch: restricts blood flow to other organs (ex: skin, gonads, kidneys)
  - Affects metabolic rate and sexual function



The Stress Response

Glucocorticoid Hormones:

- Bind to many body tissues and prepares body to respond to threats
  - Stimulates production and release of sugar from sites like liver
- Binds to brain areas to activate attention and learning
- Inhibits growth and immune responses until threat ends



The Stress Response

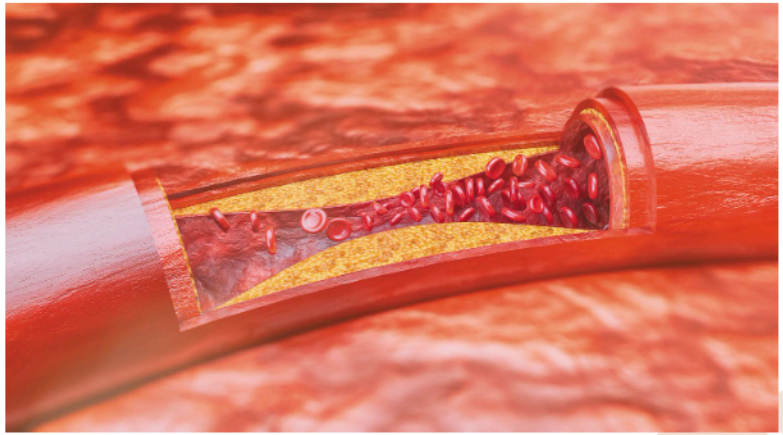
Adrenal Glands:

- Pump out epinephrine and glucocorticoid hormones during chronic stress
- If animals are exposed to these hormones for too long, there could be negative long term consequences

Chronic Stress

Overexposure to glucocorticoids:

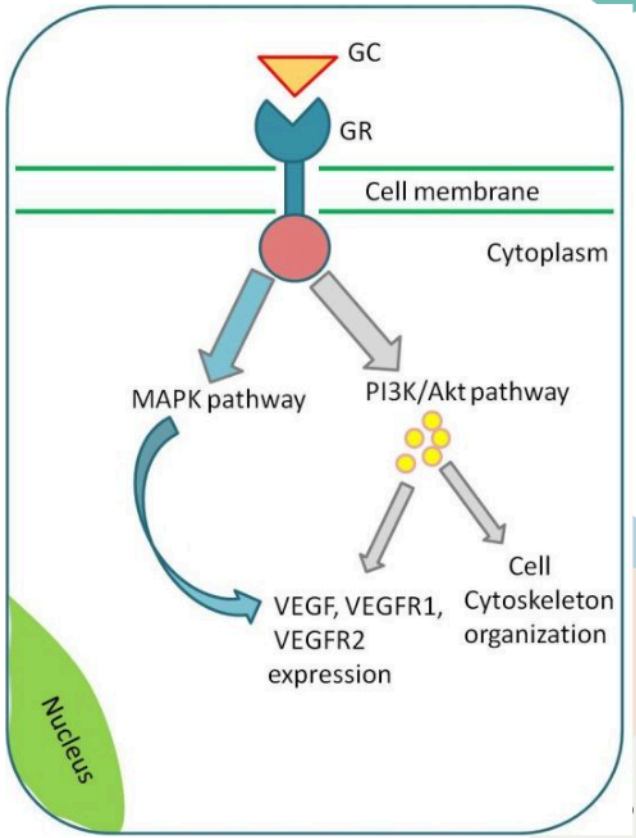
- Can cause muscles to atrophy, push the body to store energy as fat, and keep blood sugar too high
  - Could amplify diabetes systems
- Could develop hypertension and atherosclerosis
  - Increases risk of heart attacks
- Reduces infection and inflammation resistance



Chronic Stress

Glucocorticoids' effect on development:

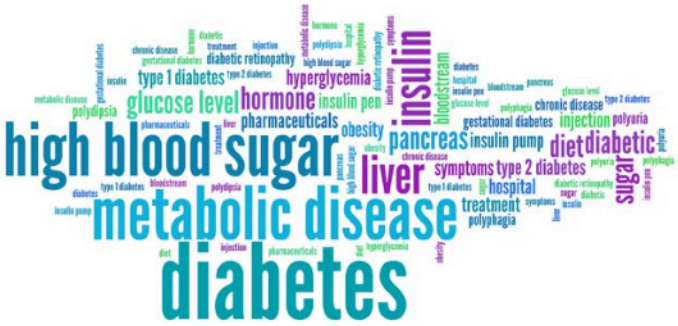
- Chronic stress in pregnant women leads stress hormones to cross placenta as fetus develops
- Glucocorticoids = transcription factors
  - Binds to DNA and determines gene expression
- High blood levels of glucocorticoids in mothers → babies have low birth weights and more sensitive stress responses



Chronic Stress

Metabolic stressors:

- Could include starvation, causing high levels of glucocorticoids
- Stressful environments push fetuses to develop metabolisms that are sensitive to stress
  - Metabolisms will store fat more easily
- Increases risk of obesity or diabetes, along with other metabolic diseases

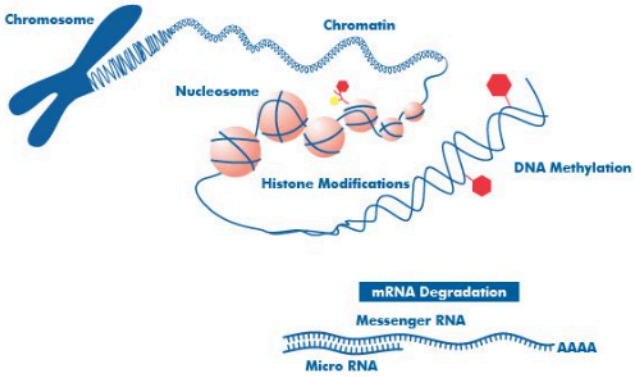


Chronic Stress

Family history:

- Stress effects can be passed down by epigenetic mechanisms
  - Can change DNA molecules' markers that show which genes are expressed/which aren't

- When cells that develop in eggs or sperm change (in markers), changes could be passed to offspring
  - Studies shown in animal tests



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We hope you enjoyed the workshop!

Any questions?

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