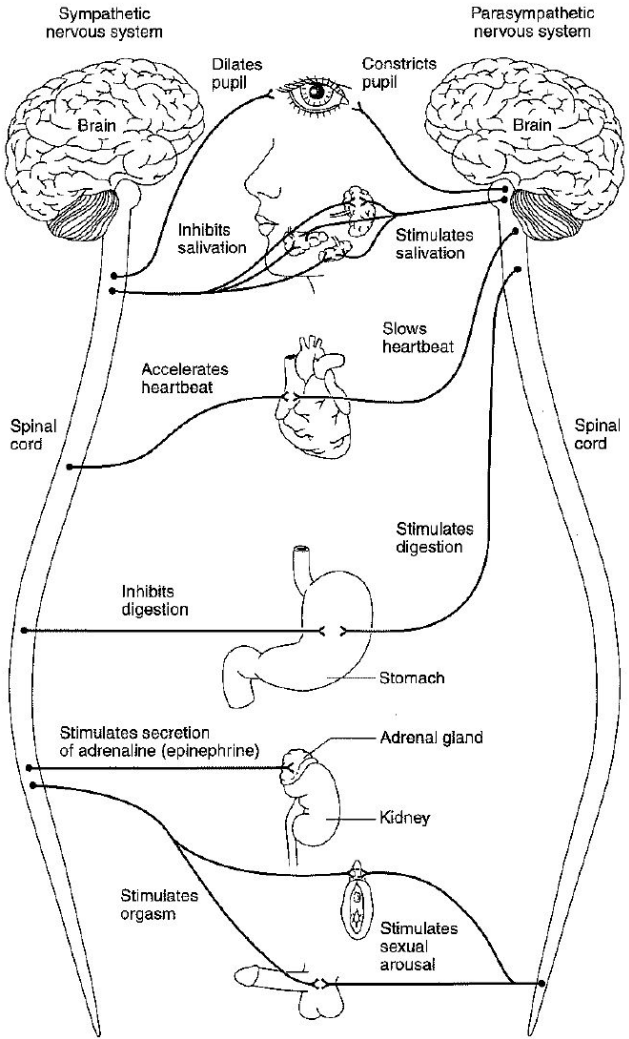
Basic logic of stress response

Emergency disruption of homeostasis - we need energy! Mobilize energy for immediate use to equilibrate and reestablish/maintain homeostasis.

Catabolize glucose & shunt energy and oxygen to vital functions - heart, brain, liver.

Shut down “long-term projects” - anabolism (digestion, tissue building, energy storage), reproduction, and memory.

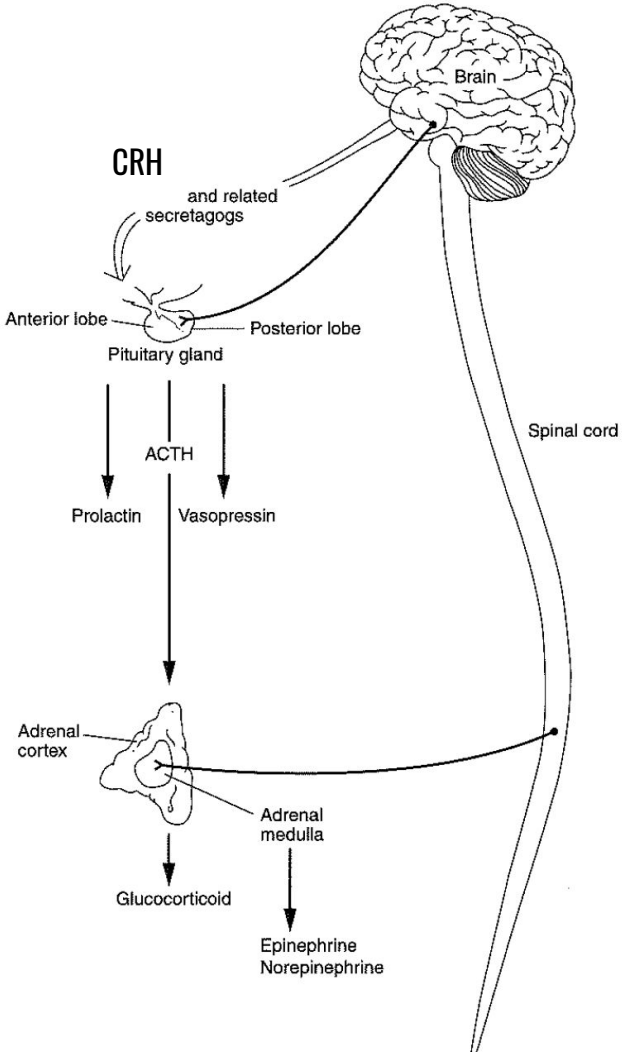
Even suppress inflammation – healing will slow us down.



Two major branches of stress response

Boh involving adrenal glands -

1. **sympathetic system & catecholamines (immediate response - sec-min)**

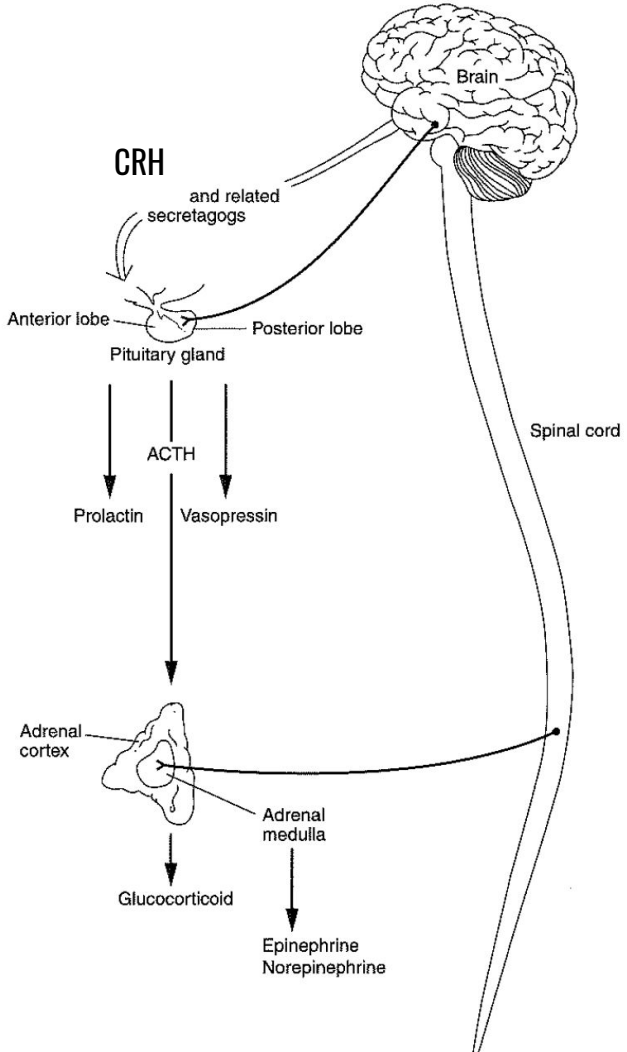


Two major branches of stress response

Boh involving adrenal glands -

1. sympathetic system & catecholamines (immediate response - sec-min)
2. **HPA axis & glucocorticoids (sustained response - min-hrs).**

   (main GC is cortisol in humans, corticosterone in rodents)



Two major branches of stress response

Boh involving adrenal glands -

1. sympathetic system & catecholamines (immediate response - sec-min)
2. HPA axis & glucocorticoids (sustained response - min-hrs).

Time course of two branches differs as do effects (adaptive & maladaptive) on target tissues depending on stressor exposure/perception.

Important to recognize

Glucocorticoids are critical to circadian rhythms of energy availability and insulin activity

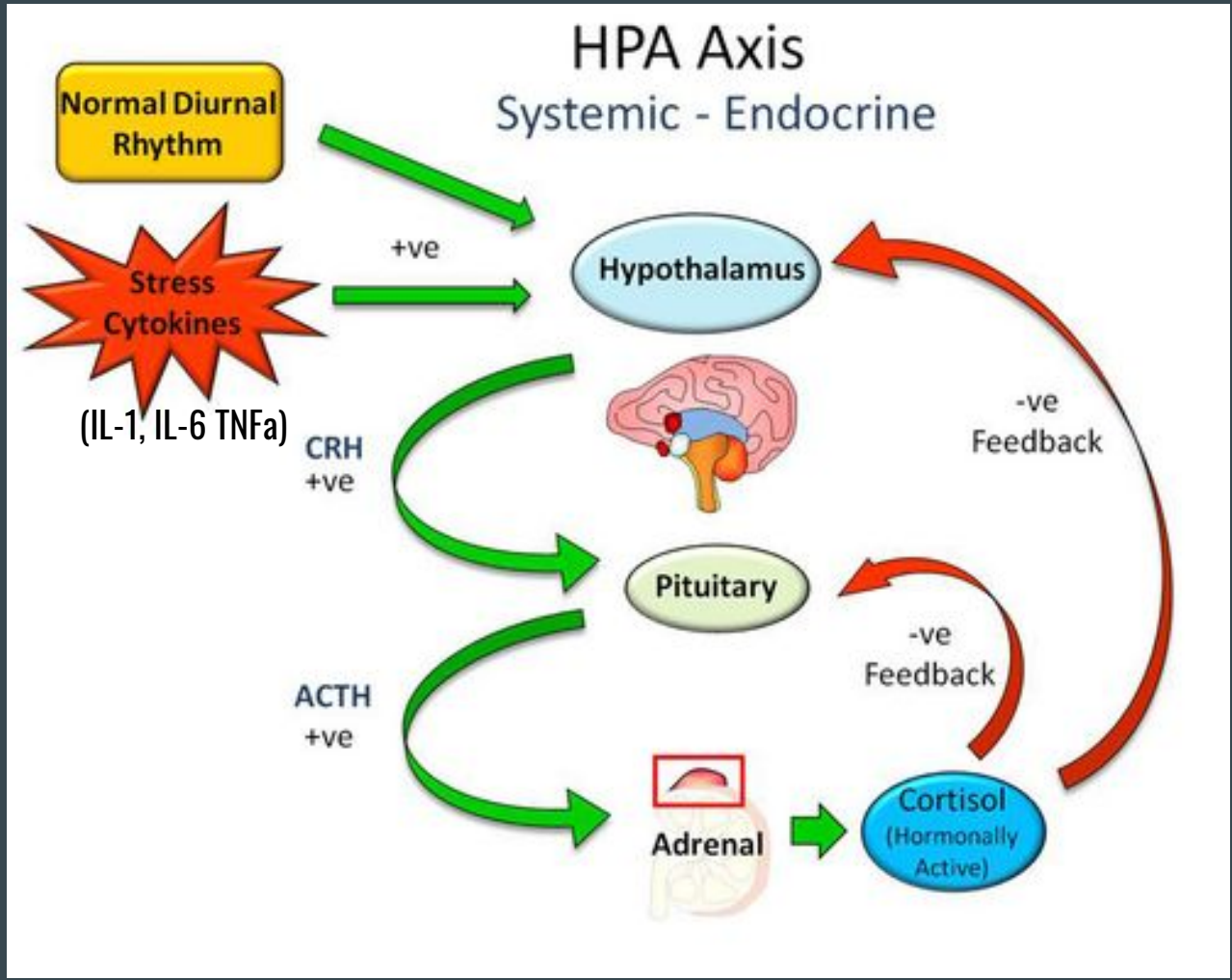
The stress response is adaptive

Basic biology of the stress response and circadian rhythm is not one of pathology

Sustained or overactivation of stress response causes damage, increasing risk of particular pathologies

Glucocorticoid response

Negative feedback



Metabolic stress response

GCs, catecholamines, and glucagon inhibit insulin secretion

And so inhibit storage of free energy substrates

Fat cells stop uptake of glucose and synthesis of triglycerides, begin lipolysis - breaking down fat for useable energy

Non-exercising muscle stops uptake of glucose and glycogen synthesis

Liver begins gluconeogenesis - creating glucose from smaller substrates

Disease state: myopathy - muscle wasting, insulin resistance → type II diabetes

Cardiovascular stress response

Overall: increased cardiovascular activity

Primarily orchestrated by sympathetic branch (epiniephrine, norepinephrine, dopamine)

“Sympathetic tone” increases to mobilize glucose and oxygen to exercising muscle:

Vasoconstriction of blood vessels to increase blood pressure (mobilizes oxygen faster)

Vasopressin increases blood volume by causing kidneys to retain water (increasing blood pressure)

Heart beats faster (to mobilize oxygen) and stronger (bc increased blood pressure)

Disease state: hypertension, artherosclerosis

Reproductive stress response

Overall: suppression of reproduction in numerous creative ways

CRH and endorphins inhibit secretion of GnRH in hypothalamus

Prolactin inhibits sensitivity of pituitary gland to GnRH

In females:

- decreases LH and FSH, decreasing _____
- lower progesterone levels and high prolactin impede maturation of uterine wall, impede implantation
- if stressor → fat loss, reduced estrogen bc fat cells not available to aromatize testosterone

In males:

- glucocorticoids further inhibit testes sensitivity to LH, decreasing _____
- inhibition of parasympathetic tone disrupts erection

Digestive stress response

Sympathetic activation decreases salivation and digestion → lowering stomach acid production

Disease state: cells of stomach wall acclimate to less acid, secrete less protective mucus, when acid returns to normal level, acid damages stomach wall → ulcers

H. pylori accelerates damage to stomach wall cells, promoting ulceration

Stress response and growth/repair

Always important to tease apart whether nutritional deprivation or the stress response *per se* affecting physical growth and maintenance.

Stress response inhibits anterior pituitary from releasing GH

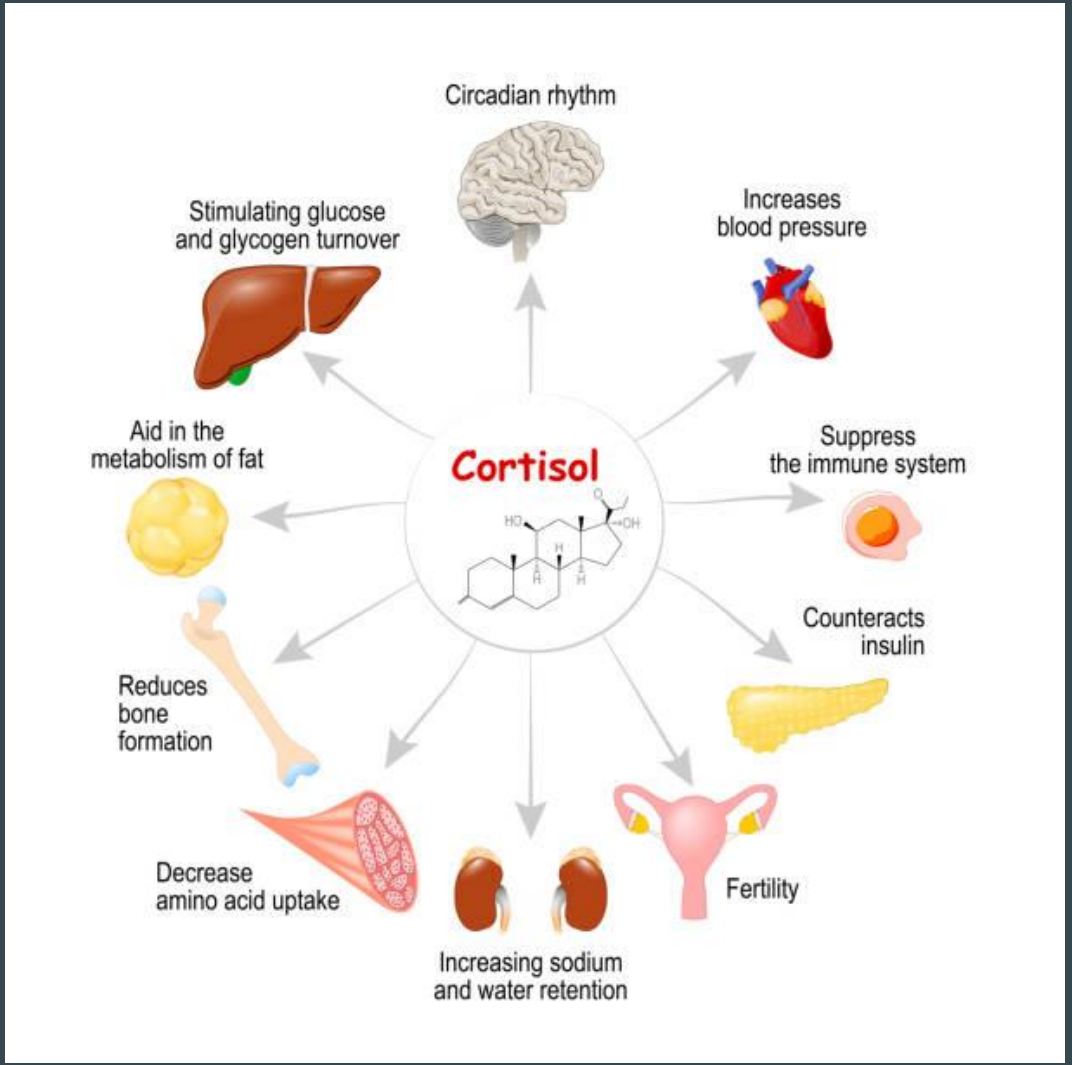
- primarily bc hypothalamus releases more somatostatins, great inhibitors

In young – stunts growth, though catch-up growth common

In adults – inhibits cellular repair

Disease state: decalcified bone,

Summary of cortisol targets



Psychological stress

Perception of the degree of threat plays a strong role in stress response in animals capable of cognitive association and some future-casting

Humans excellent at both

However, stress response is not only commensurate with extent it produces emotional arousal

Psychological stress

Sources of differential stress perception, where these decrease → greater perception of threat

- Individual control in situation
- Predictability of outcome
- Available outlets for frustration - (both bullying and social support)

Psychological stress and dominance rank (animals)

Not all dominance hierarchies are equal, often species and population (ecologically) dependent

- How often does position need to be reinforced?
- How stable is hierarchy overall?
- What is individual experience within hierarchy?

In identifying psychological stress, important to differentiate between it and physiological stress from rank-associated reductions to resources

Psychological stress and SES (humans)

No 1:1 mapping of dominance rank in primates and SES in humans

Multiple hierarchies within human social worlds...

Most likely scenario is that poverty yields same situation of many low-ranking non-human primates

Appendix slides...

Close look at catecholamines of sympathetic stress response

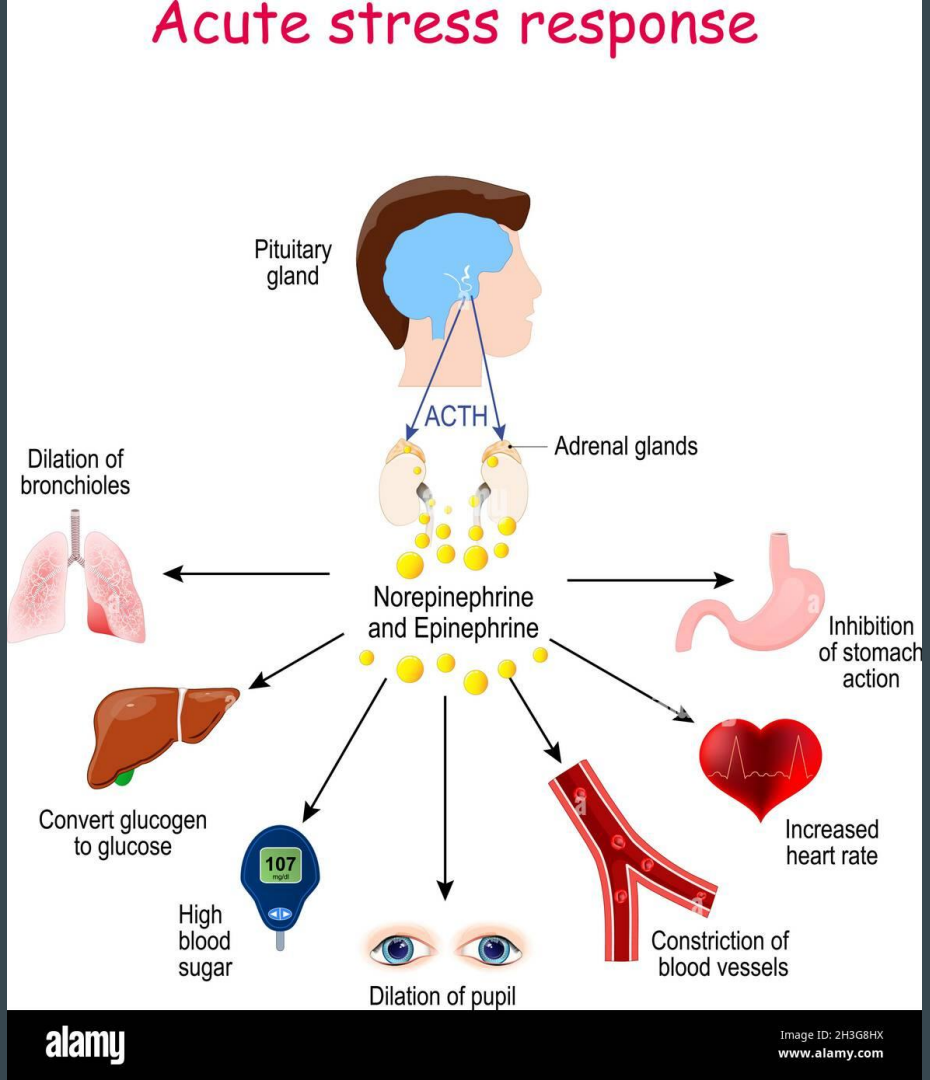
3 catecholamines involved in sympathetic stress response:

Epinephrine (adrenaline) - hormone & neurotransmitter

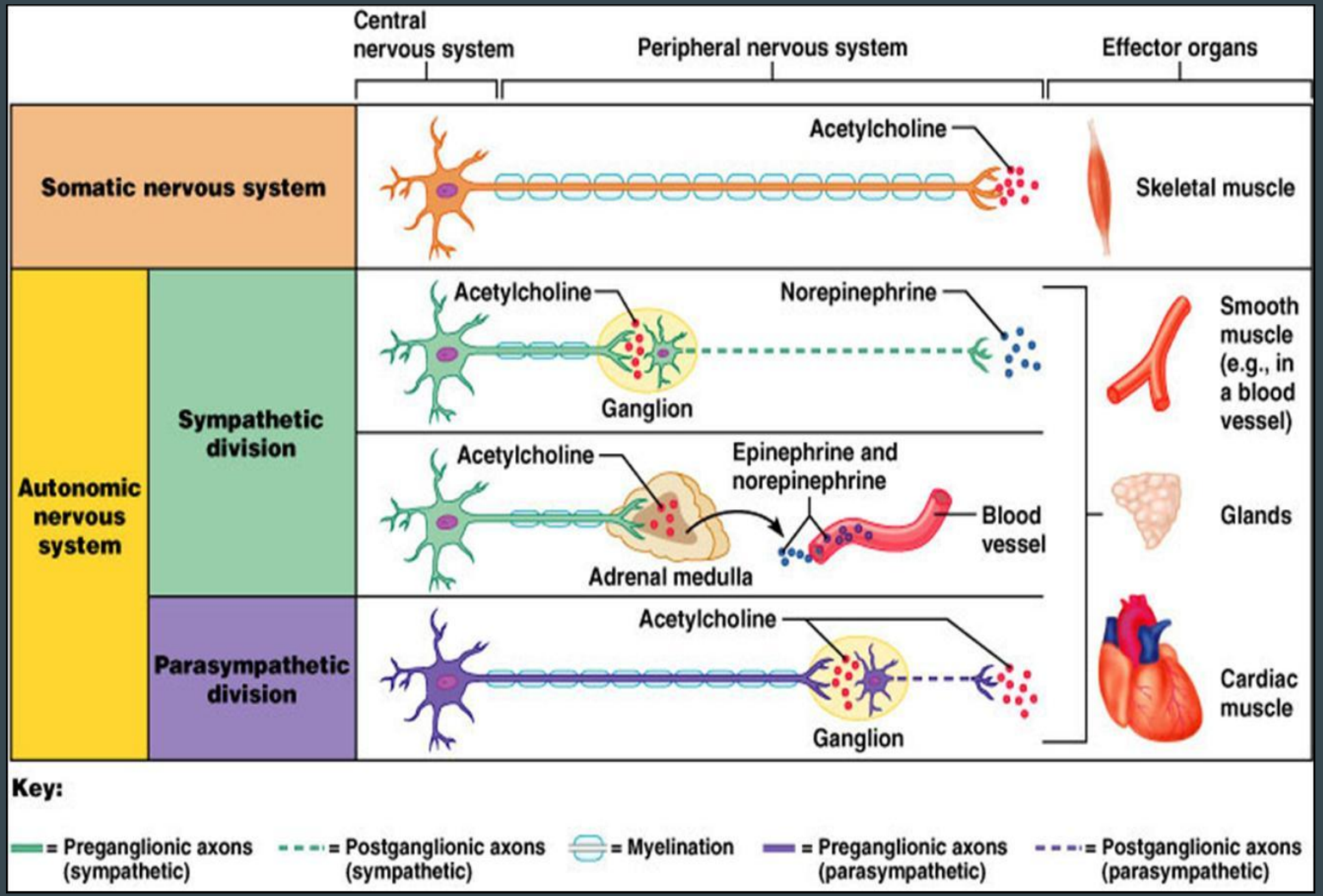
Norepinephrine (noradrenaline) - hormone & neurotransmitter

Dopamine - neurotransmitter

Target tissues of epinephrine & norepinephrine



Sympathetic nervous system in context



Neurotransmitters in context of the nervous system