Chemistry in the Endocrine System

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Endocrine System

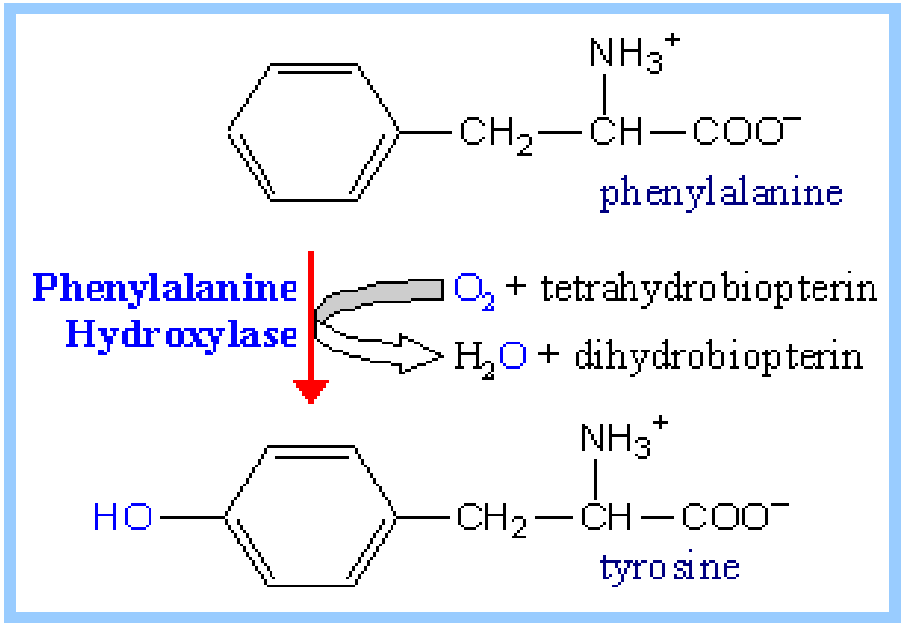
- Secreting hormones (chemical messengers) to regulate the functions of the body
- Glands and organs
  - Pancreas
  - Hypothalamus
  - Pituitary gland
  - Thyroid gland
  - Adrenal gland
  - Pineal gland
  - Reproductive glands

Phenylalanine

- Amino acid in hemoglobin
- "Essential amino acid"
  - Required for normal functioning in humans
  - Through diet

Chemistry of Phenylalanine

- $C_9H_{11}NO_2$
- 2-amino-3-phenylpropanoic acid
- Produces tyrosine



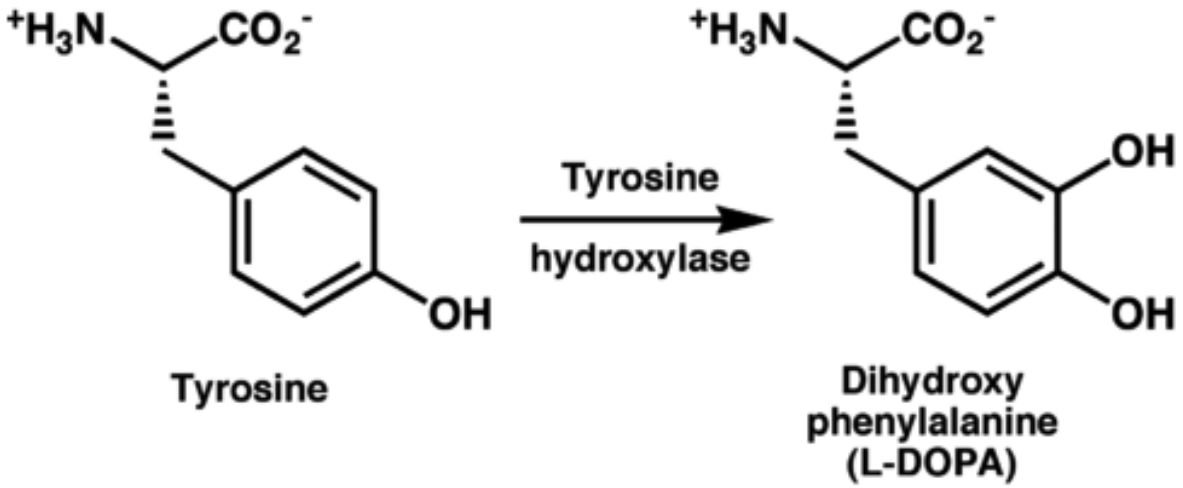
https://www.rpi.edu/dept/bcbp/molbiochem/MBWeb/mb2/part1/aacarbon.htm

Tyrosine

- Amino acid in insulin
- Precursor of dopamine, thyroid hormones, and adrenaline
- Can be synthesized by the human body

Chemistry of Tyrosine

- $C_9H_{11}NO_3$
- 2-amino-3-(4-hydroxyphenyl)propanoic acid
- Produces DOPA



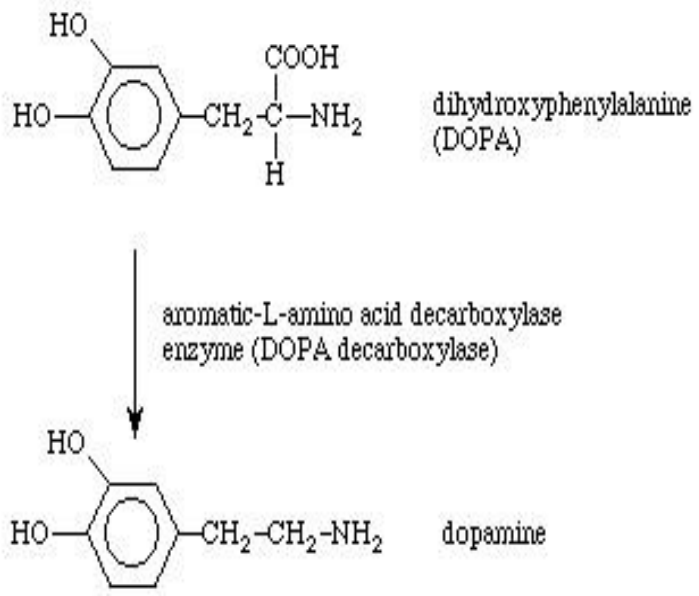
http://www.smartnootropics.co.uk/tyrosine/

DOPA

- Dihydroxyphenylalanine
- Nonstandard amino acid
  - Not found in proteins
- Treatment for Parkinson's disease

Chemistry of DOPA

- $C_9H_{11}NO_4$
- 2-amino-3-(3,4-dihydroxyohenyl)propanoic acid
- Produces dopamine



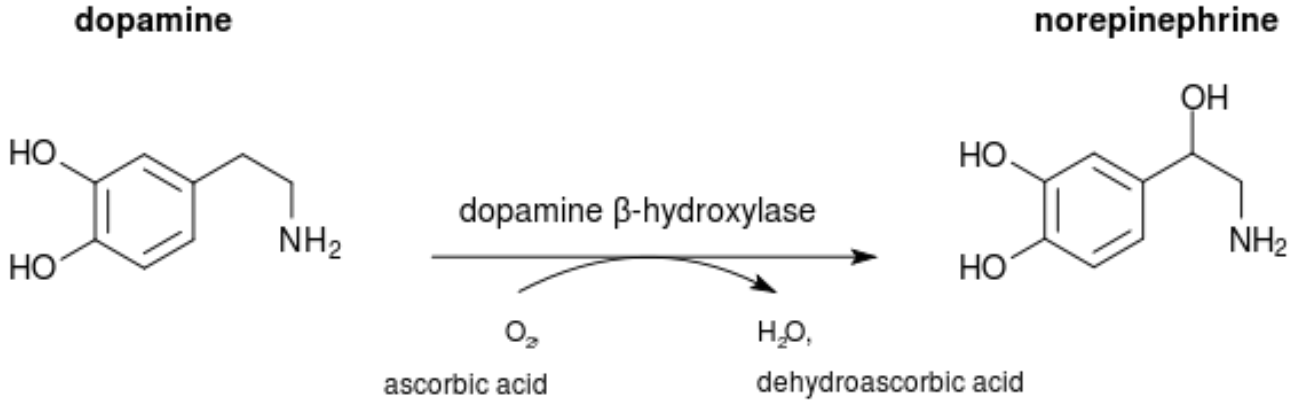
https://courses.washington.edu/chat543/cvans/popups/dopadeca.html

Dopamine

- Produced by the hypothalamus
- Relays messages to control movement of the body
- Low levels of dopamine causes abnormal brain activity; sign of Parkinson's disease
  - Administer DOPA
- Cardiopulmonary resuscitation

Chemistry of Dopamine

- $C_8H_{11}NO_2$
- 4-(2-aminoethyl)benzene-1,2-diol
- Produces norepinephrine



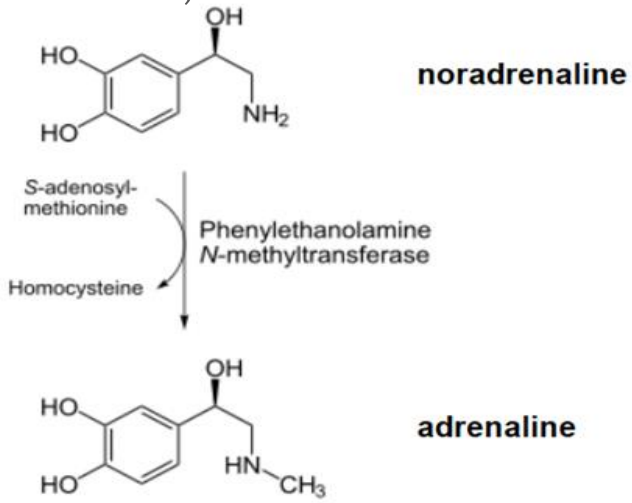
http://en.wikipedia.org/wiki/Dopamine_beta-monooxygenase

Norepinephrine

- AKA noradrenaline
- Hormone
  - Secreted by the adrenal medulla
- Neurotransmitter
  - Secreted from neurons
- Fight-or-flight response
  - Heart rate
  - Glucose release
  - Skeletal muscle readiness

Chemistry of Norepinephrine

- $C_8H_{11}NO_3$
- 4-[(1R)-2-amino-1-hydroxyethyl]benzene-1, 2-diol
- Produces epinephrine



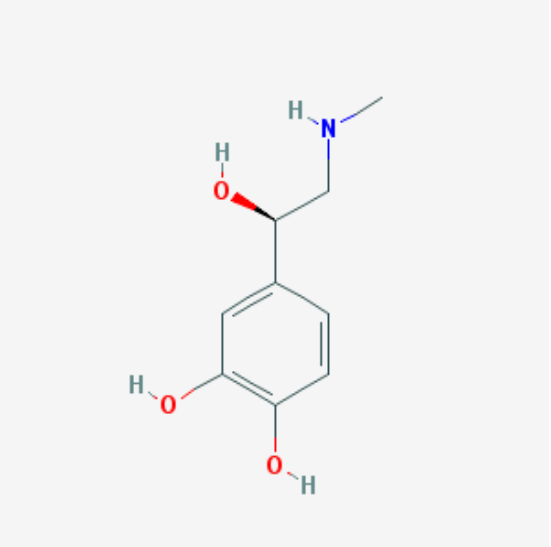
http://brainimmune.com/endogenous-catecholamines-in-immune-cells-discovery-functions-and-clinical-potential-as-pharmacotherapeutic-targets-3/

Epinephrine

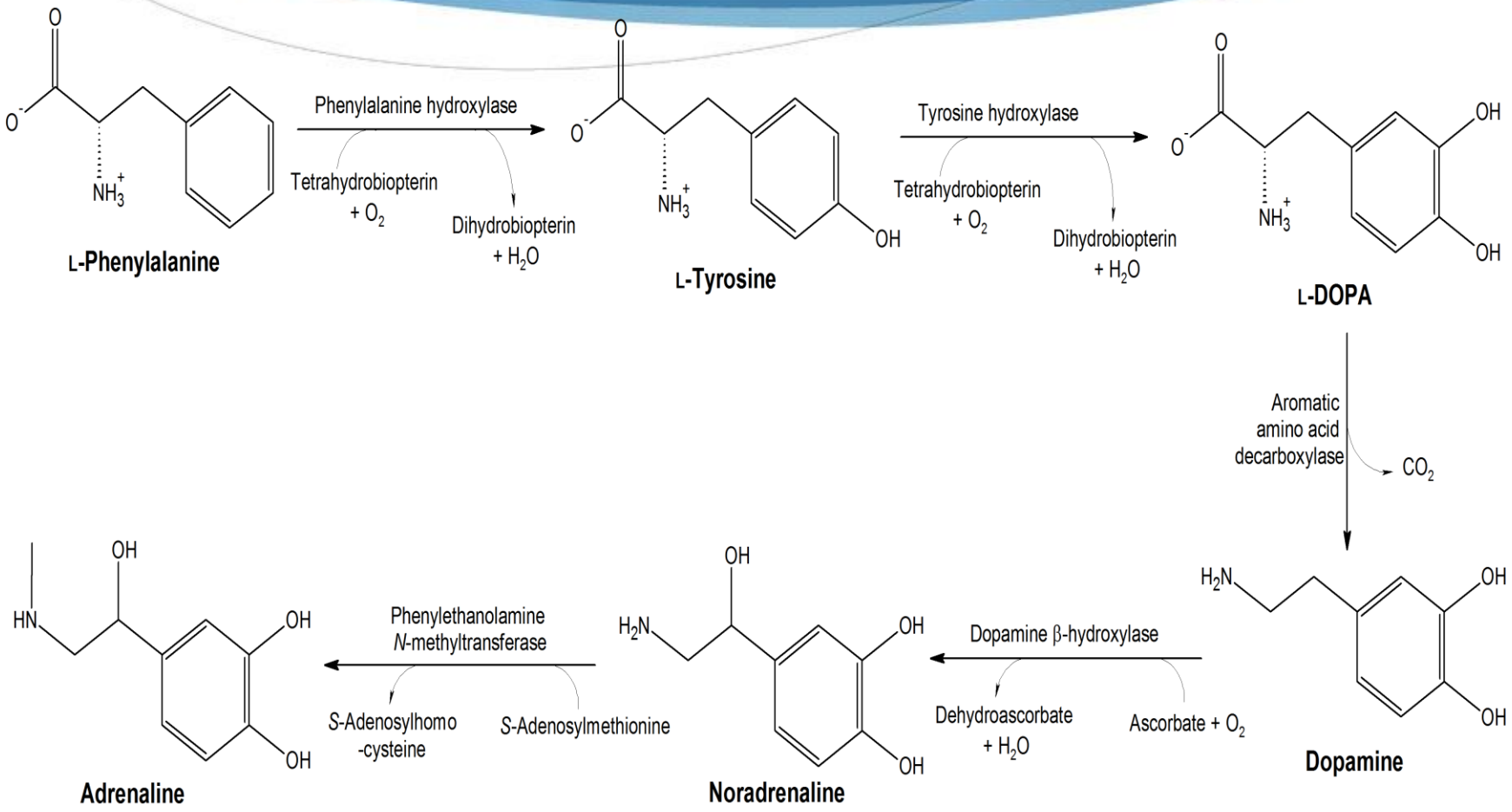
- AKA adrenaline
- Secreted by the adrenal medulla
- Stimulates actions of the fight-or-flight response
  - Increasing supply of oxygen
  - Increasing supply of glucose to the brain and muscles
- Used in cardiac failure

Chemistry of Epinephrine

- $C_9H_{13}NO_3$
- 4-[(1R)-1-hydroxy-2-(methylamino)ethyl]benzene-1,2-diol



http://pubchem.ncbi.nlm.nih.gov/compound/5816#section=Top


L-Phenylalanine
Phenylalanine hydroxylase
Tetrahydrobiopterin
+ O2
Dihydrobiopterin
+ H2O
L-Tyrosine
Tyrosine hydroxylase
Tetrahydrobiopterin
+ O2
Dihydrobiopterin
+ H2O
L-DOPA
Aromatic
amino acid
decarboxylase
CO2
Dopamine
Dopamine β-hydroxylase
Dehydroascorbate
+ H2O
Ascorbate + O2
Noradrenaline
Phenylethanolamine
N-methyltransferase
S-Adenosylhomo
-cysteine
S-Adenosylmethionine
Adrenaline

Hypothalamus & Pituitary Gland

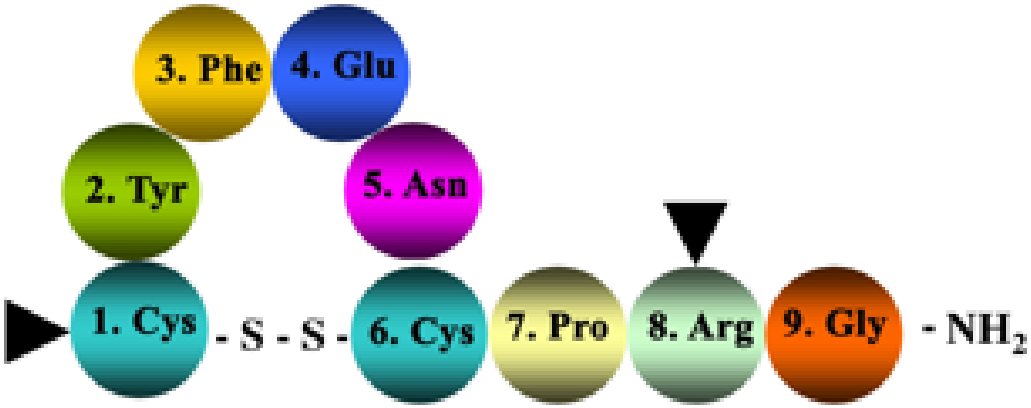
- Work together to keep normal levels of water content in the blood
  - Negative feedback
- Hormone involved: ADH

ADH

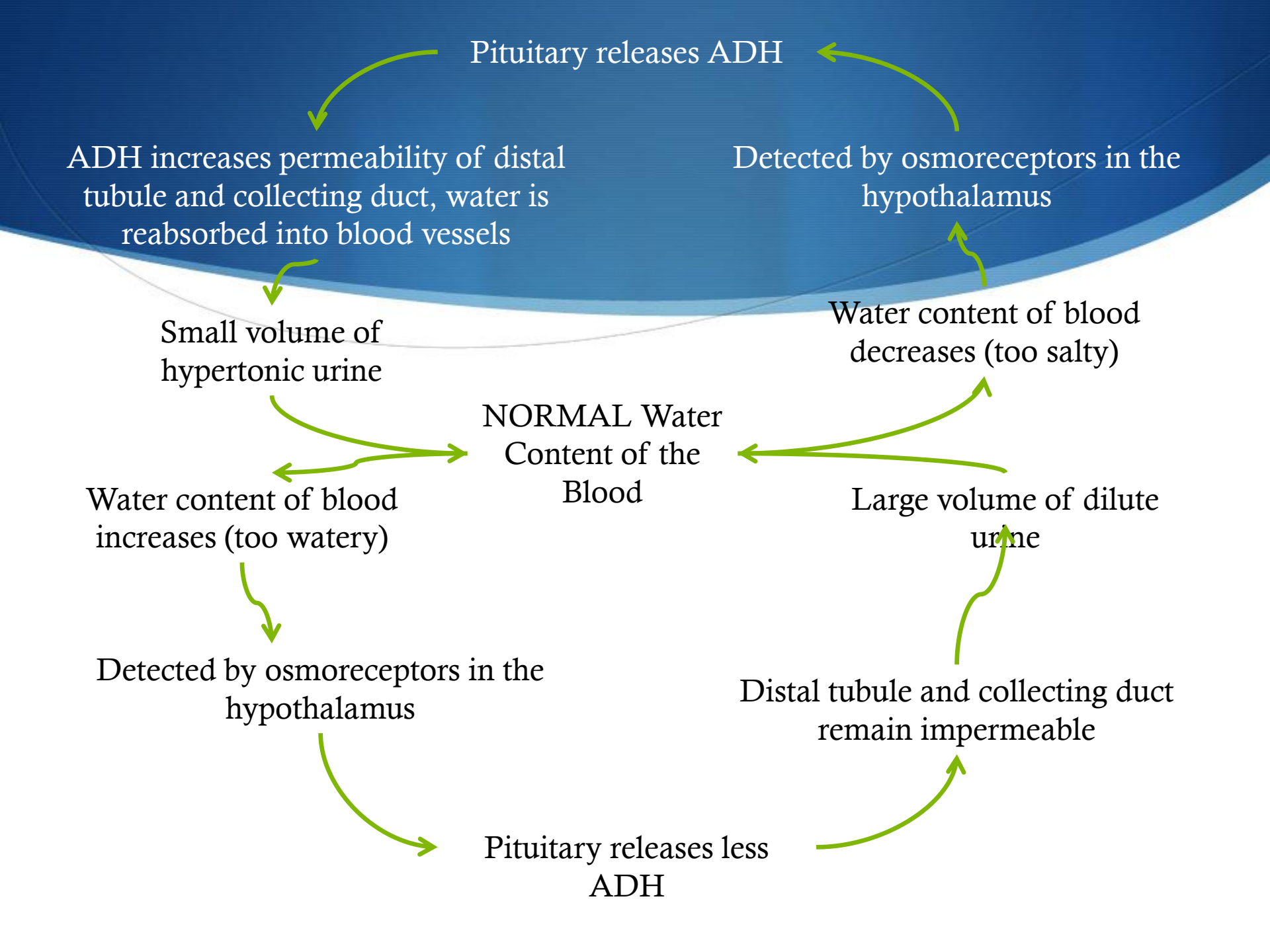
- ADH= Antidiuretic Hormone
- Made in hypothalamus
- Released by pituitary gland
- Helps prevent loss of water
  - Reduces urine output
  - Helps kidneys reabsorb water

Chemistry of ADH

- $C_{46}H_{65}N_{13}O_{12}S_2$
- Incomplete electron orbitals
  - Hydrogen bond reactions
- 9 amino acids



http://www.cancer-therapy.org/CT/v2/B/HTML/32.%20Gomez%20et%20al,%20279-290%20copy_files/image002.png


Pituitary releases ADH
ADH increases permeability of distal tubule and collecting duct, water is reabsorbed into blood vessels
Detected by osmoreceptors in the hypothalamus
Small volume of hypertonic urine
Water content of blood decreases (too salty)
NORMAL Water Content of the Blood
Water content of blood increases (too watery)
Large volume of dilute urine
Detected by osmoreceptors in the hypothalamus
Distal tubule and collecting duct remain impermeable
Pituitary releases less ADH

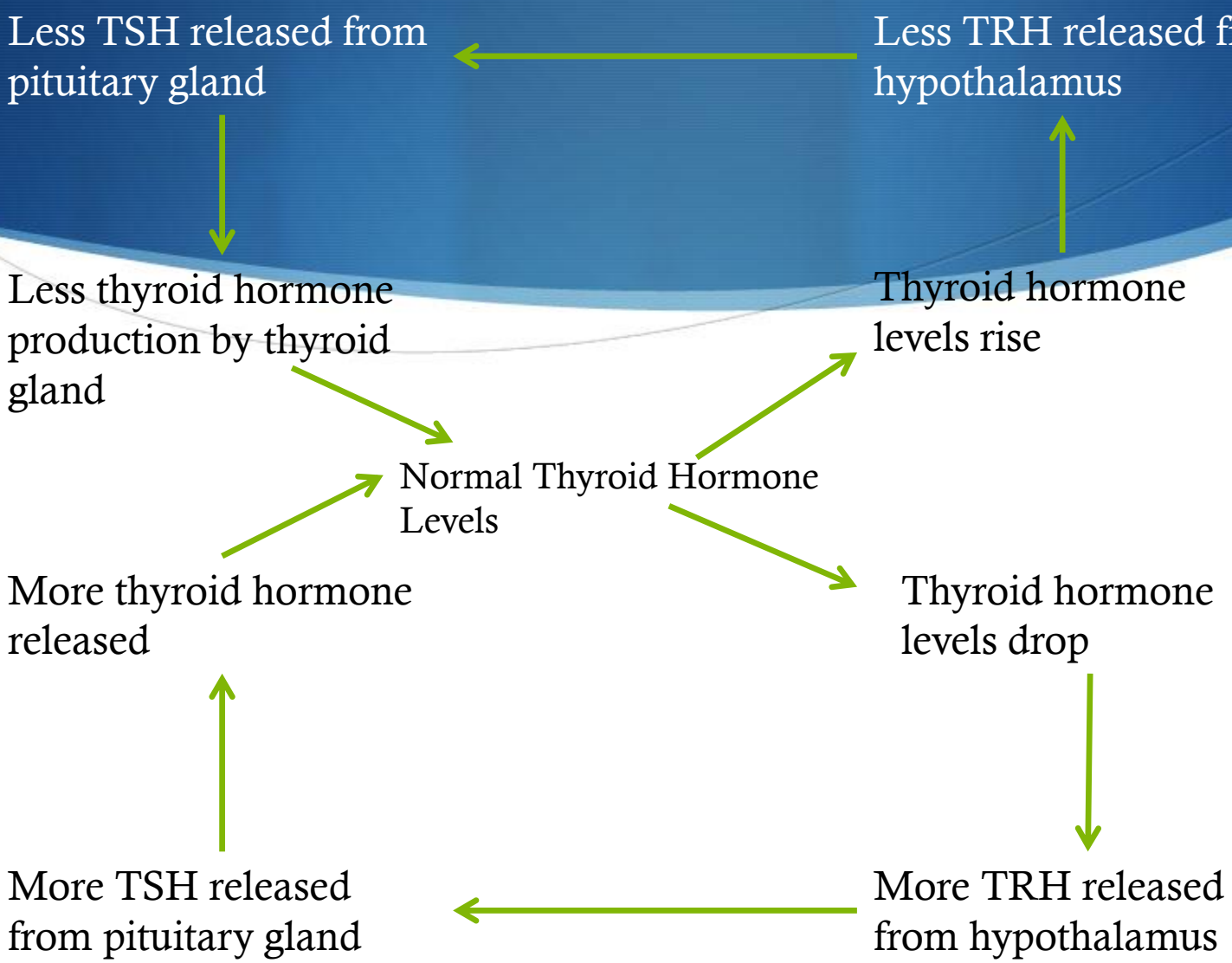
Hypothalamus & Pituitary Gland

- Work together to keep normal levels of thyroid hormones
  - Negative feedback
- Hormones involved: TRH, TSH

TRH & TSH

- TRH= Thyrotropin-releasing hormone
- Synthesized & released by hypothalamus
- Stimulates the release of TSH

- TSH= Thyroid-stimulating hormone
- Production triggered when TRH is released
- Causes thyroid gland to make T3 and T4


Less TSH released from pituitary gland
Less TRH released from hypothalamus
Less thyroid hormone production by thyroid gland
Thyroid hormone levels rise
Normal Thyroid Hormone Levels
More thyroid hormone released
Thyroid hormone levels drop
More TSH released from pituitary gland
More TRH released from hypothalamus

ACTH

- Adrenocorticotropic hormone/corticotropin
- Stimulates the adrenal glands to release cortisol
- Secreted from pituitary gland
- Released in response to CRH

Cortisol

- Steroid hormone
- Produced by adrenal gland
- Stress hormone
- Release of ACTH stimulates the production and release of cortisol
- Cortisol is transported to the tissues

Citations

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