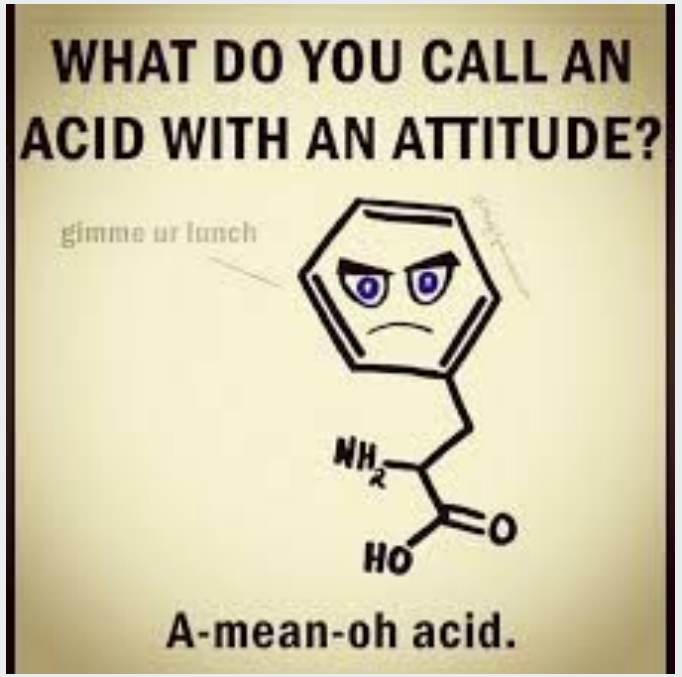
Proteins

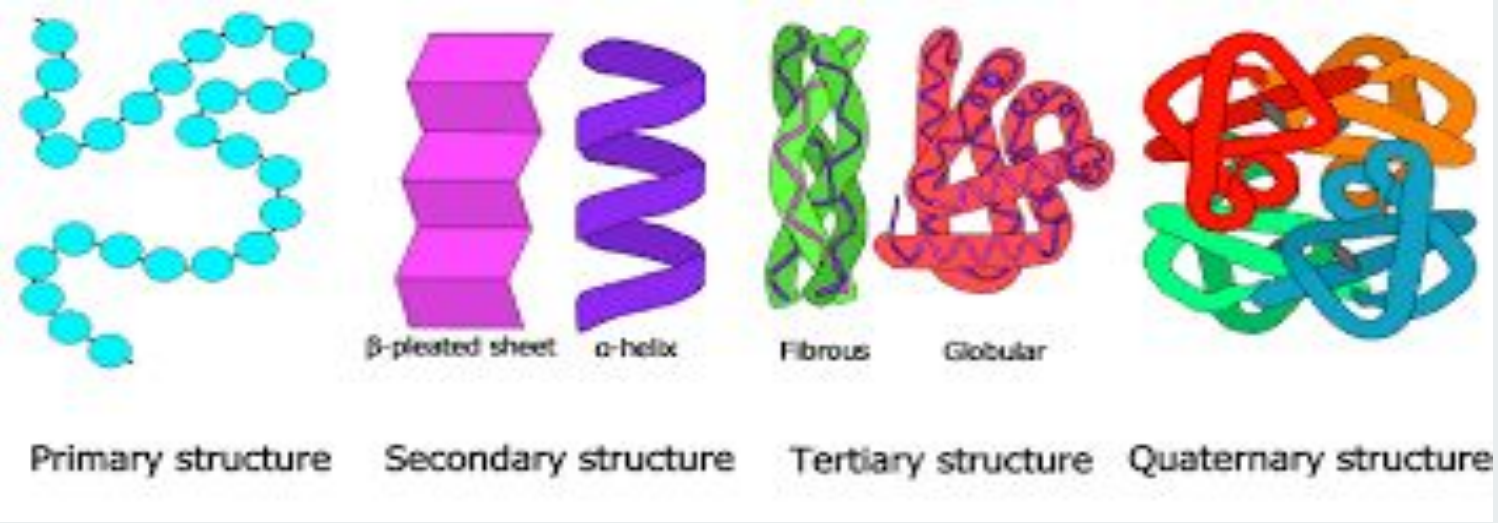

WHAT DO YOU CALL AN ACID WITH AN ATTITUDE?
gimme ur lunch
NH2
HO
O
A-mean-oh acid.

Protein Overview

https://youtu.be/qx-H9zlDeR0?si=M3ogdC0WzxGlqiZM

Protein

- Proteins are arranged as strands or chains of amino acids
- **Amino acids** – the building blocks of proteins – all types consist of the same basic structure however the side chain changes. 20 different kinds.
- **Essential amino acids** – cannot be synthesized by the body or cannot be synthesized in quantities sufficient to meet body needs. Must be obtained through dietary sources.
- **Peptide bonds** – how amino acids are linked in order to create proteins



Protein Structures

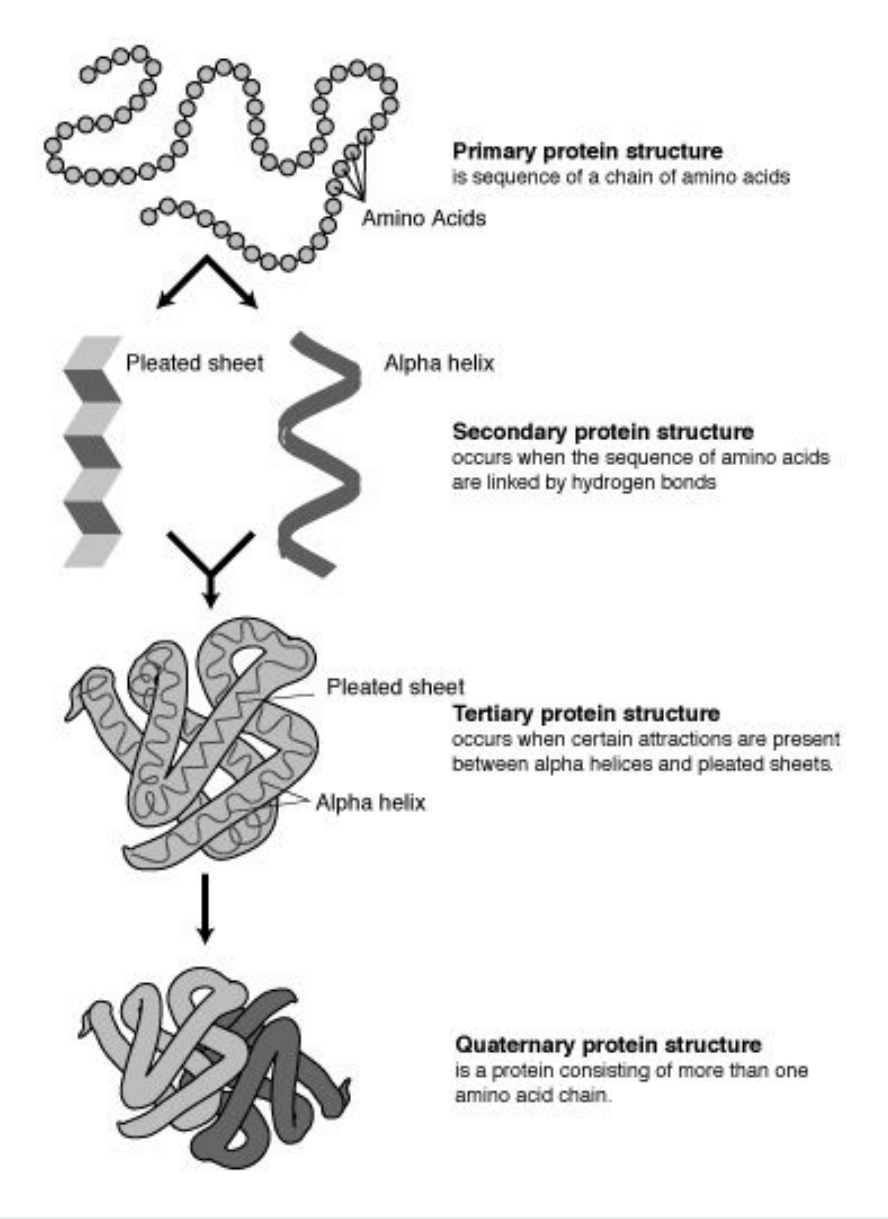
Primary - chains of amino acids such as in Insulin

Secondary - Interactions between atoms in the backbone of the polypeptide (does not involve R groups) Produces most often a helix or pleated sheet shape.

Tertiary - 3D structure of the protein. Due to interactions between the R groups.

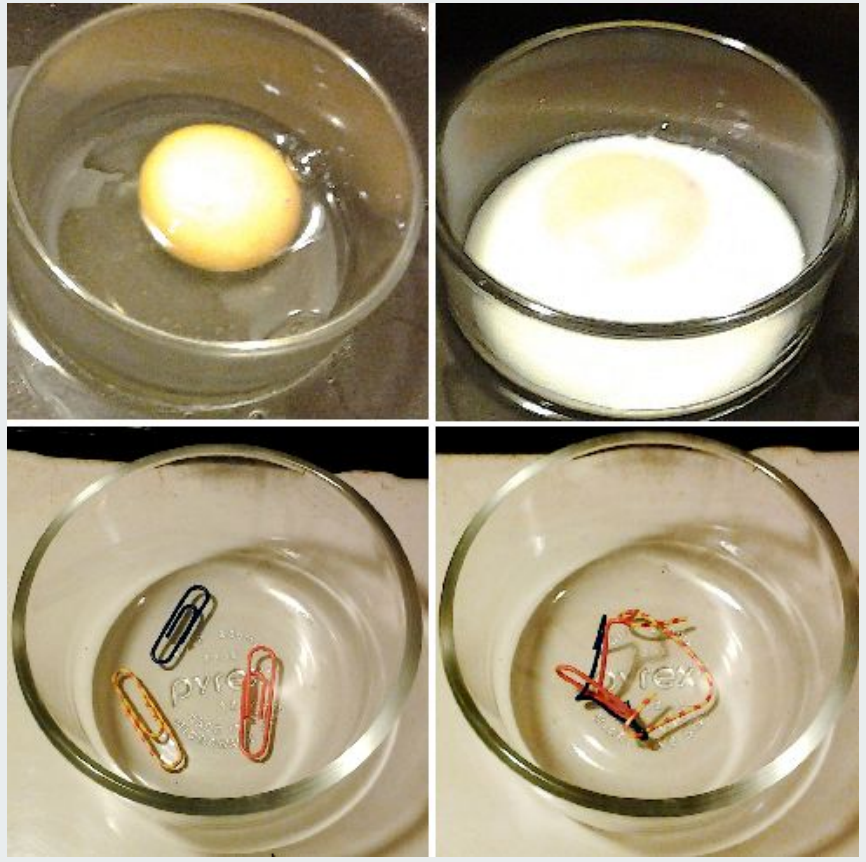
Quaternary - Only some proteins have this shape, when subgroups join together. One example is Hemoglobin, which has four subgroups.

Denaturation - When a protein loses its 3D shaping, & is reduced to its primary structure. Usually makes the protein non-functional. Can sometimes be reversed but often not - think of an egg white which becomes solid & opaque after heating and will not become clear again once cooled.

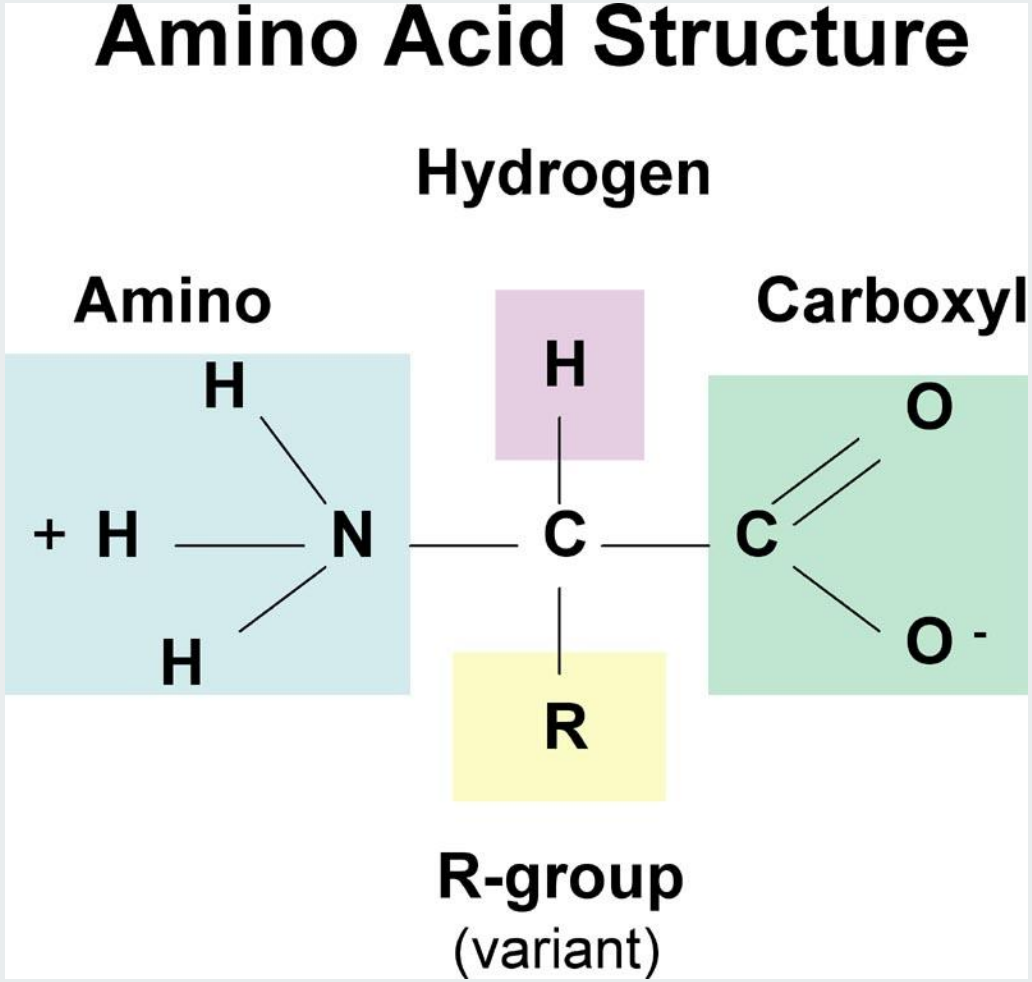


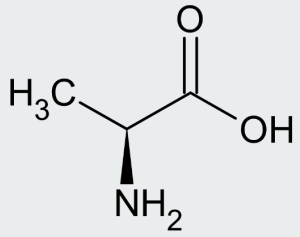
Denaturation

- **Denaturation** – the **irreversible** (usually) change in a protein's shape brought about by heat, acids, bases, alcohol, salts of heavy metals, etc.
-
- https://youtu.be/oyzx7ttssss?si=HMqgcXu1zdxVF0n_

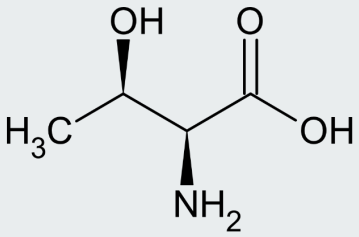


Amino Acid Structure

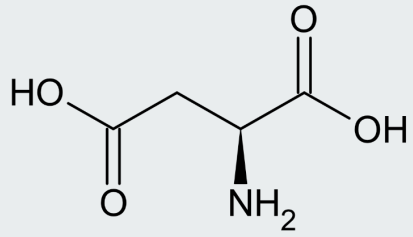




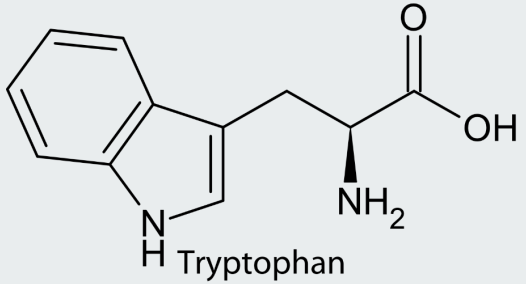
Alanine



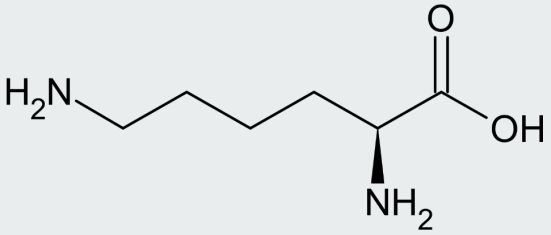
Threonine



Aspartic acid

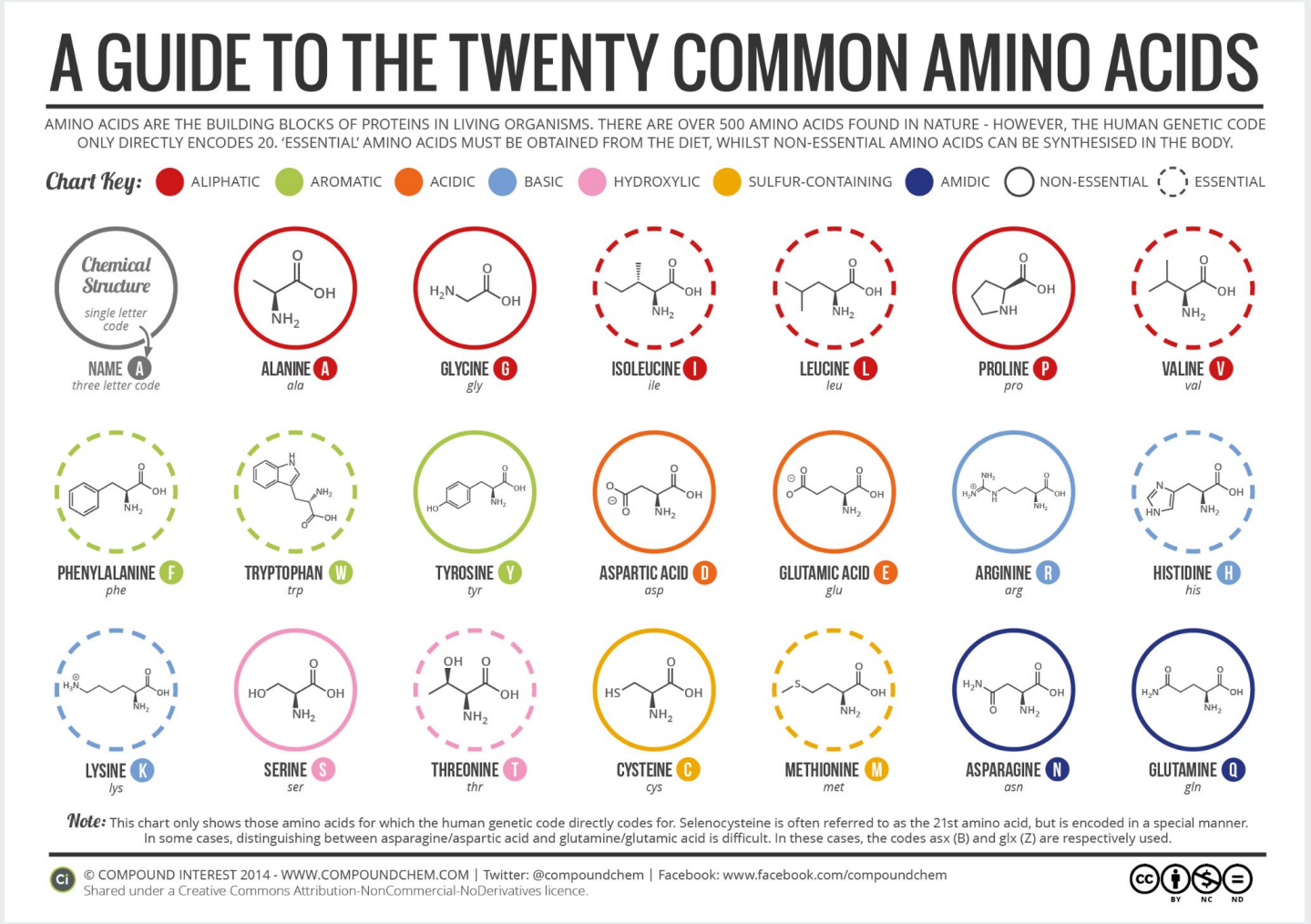


Tryptophan



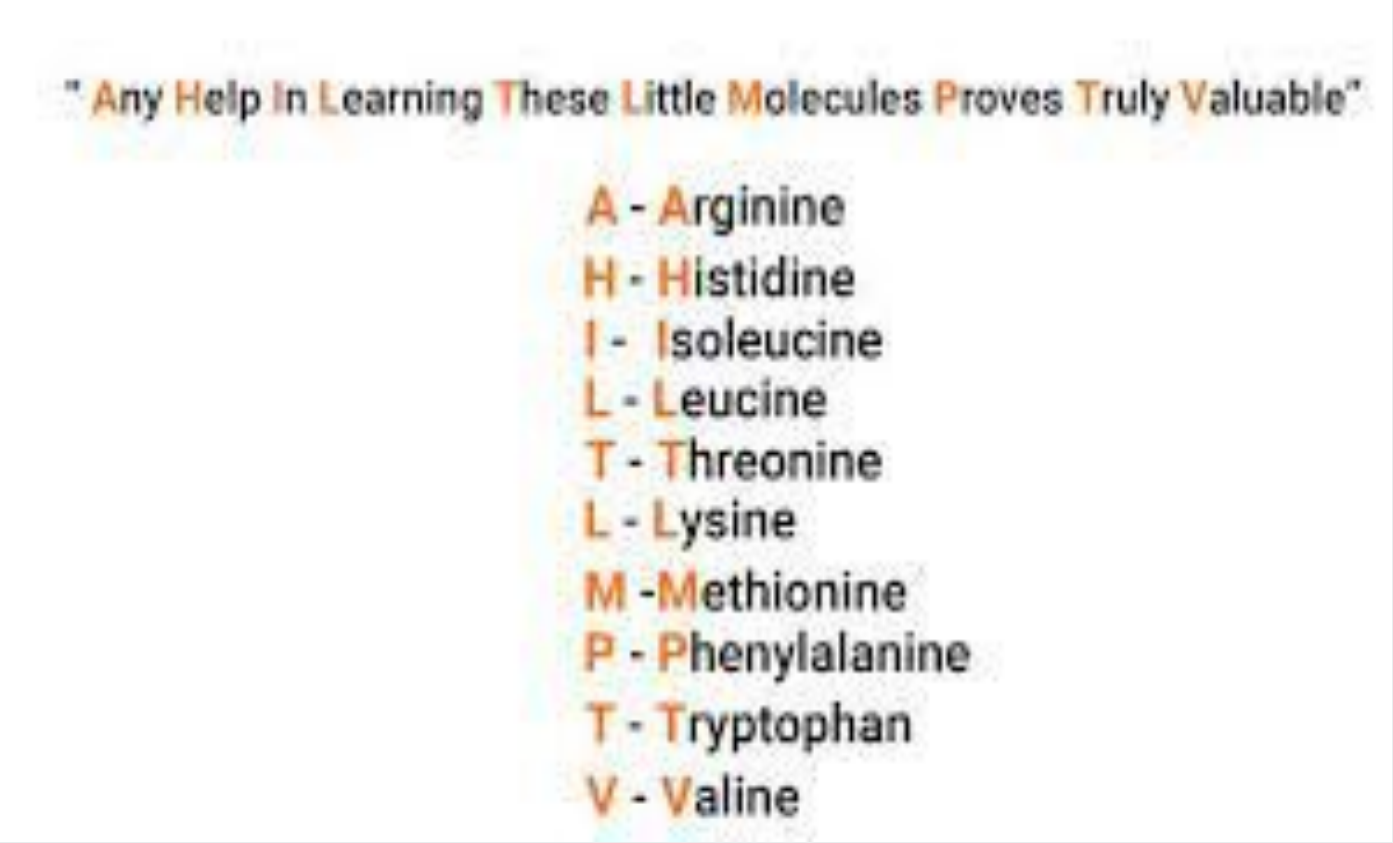
Lysine

Amino Acids are the building blocks that make proteins.



Essential Amino Acids-
MUST get in the diet

- **PVT TIM HALL (acronym)**
  - Phenylalanine
  - Valine
  - Tryptophan
  - Threonine
  - Isoleucine
  - Methionine
  - Histidine
  - Arginine
  - Leucine
  - Lysine

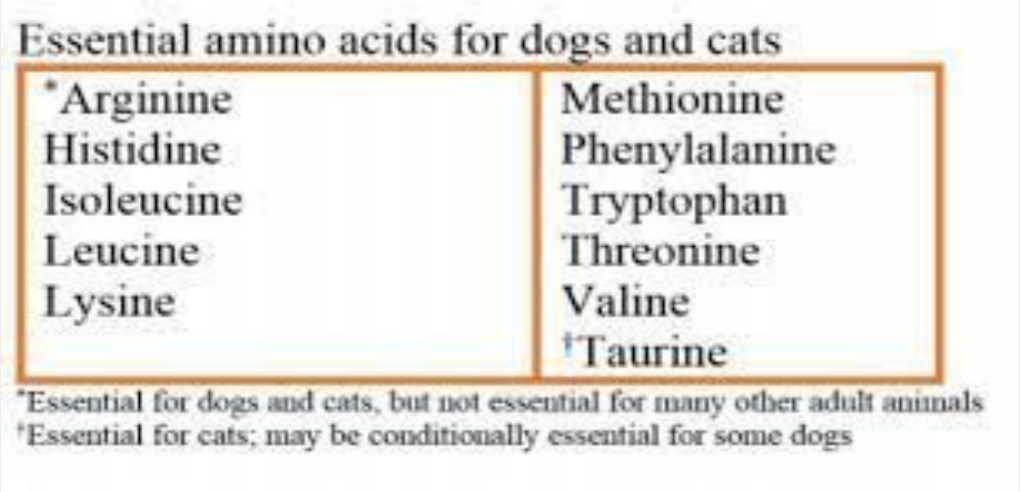


Only Amino Acids starting with P, T & A have some that are essential & some that are not

Non-Essential Amino Acids

The Human Body can make these Amino Acids from others:

- Alanine
- Asparagine
- Aspartic Acid
- Cysteine
- Glutamic Acid
- Glutamine
- Glycine
- Proline
- Serine
- Tyrosine



Essential amino acids for dogs and cats

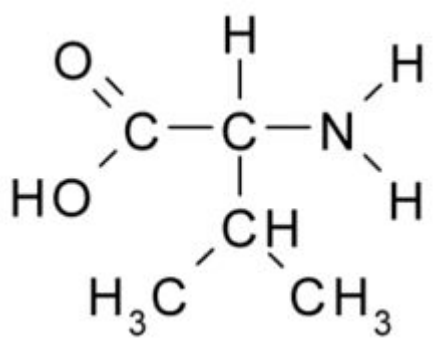
*Arginine	Methionine
Histidine	Phenylalanine
Isoleucine	Tryptophan
Leucine	Threonine
Lysine	Valine
	†Taurine

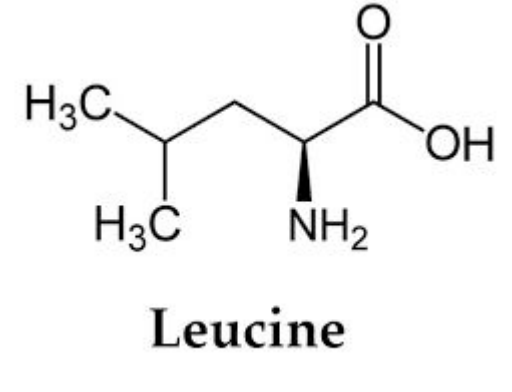
*Essential for dogs and cats, but not essential for many other adult animals
†Essential for cats; may be conditionally essential for some dogs

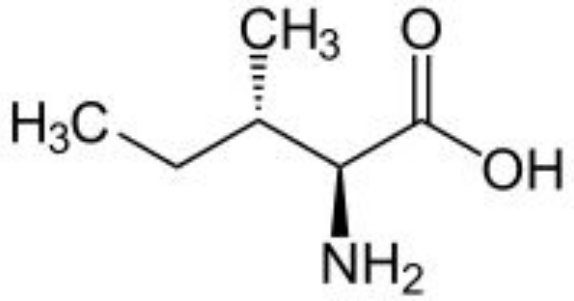
FYI - Essential amino acids varies by species

What about BCAAs?

BCAAs or Branched Chain Amino Acids are the essential amino acids leucine, isoleucine & valine. They are present in high concentrations in muscle tissues. Initial studies have shown some benefits to supplementing BCAAs before, during or after exercise to increase muscle growth, decrease post-workout soreness & reduce exercise fatigue. BCAAs have also shown some promise in treating liver disease.







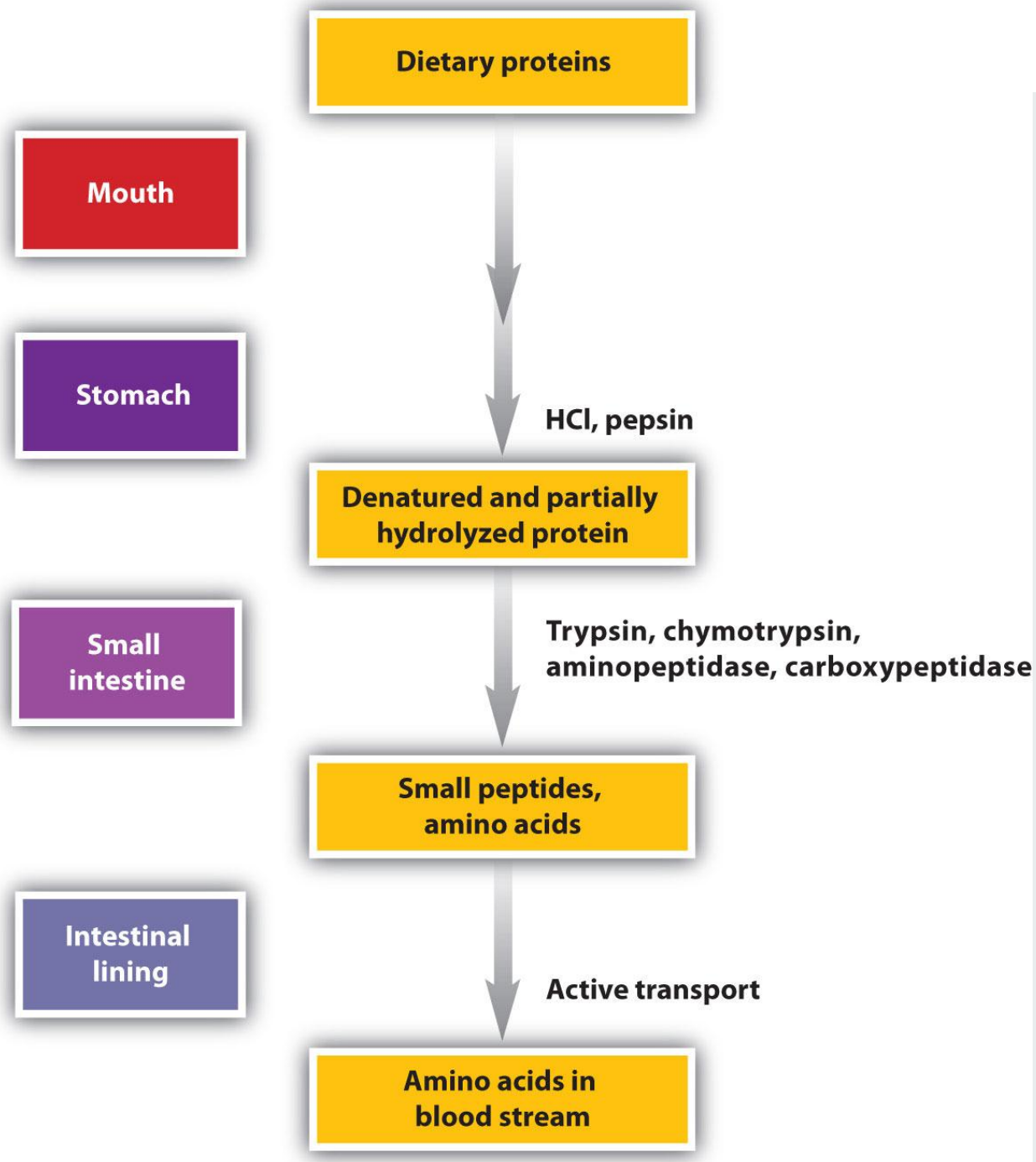
Protein Digestion

- Proteins must be broken down into amino acids prior to absorption

- **Digestive Enzymes are proteins that are resistant to being broken down by acid & other enzymes**

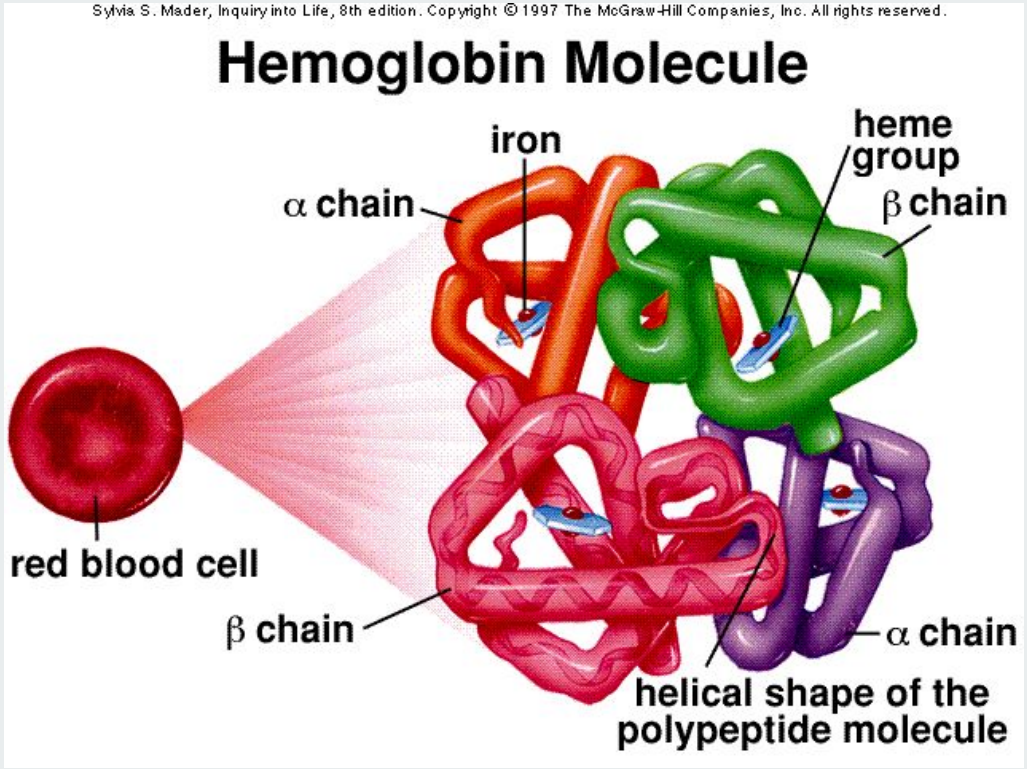
- **Stomach** – hydrochloric acid, pepsin
- **Small intestine** – pancreatic proteases, trypsin, chymotrypsin
- **Brush Border** – peptidases

- From proteins ⟶ polypeptides
- Polypeptides ⟶ di and tripeptides
- Di and Tripeptides ⟶ amino acids


Dietary proteins
Mouth
Stomach
HCl, pepsin
Denatured and partially hydrolyzed protein
Small intestine
Trypsin, chymotrypsin, aminopeptidase, carboxypeptidase
Small peptides, amino acids
Intestinal lining
Active transport
Amino acids in blood stream

Important Body Proteins

- Every cell in the body contains protein.
  1) Structural Components:
  Actin & Myosin
  Collagen
  2) Transport &/or Storage:
  Hemoglobin
  Ferritin
  3) Messenger / Hormones:
  Growth Hormone
  Insulin
  4) Antibodies
  5) Enzymes



https://youtu.be/V_E7mq8bv4g

Important Body Proteins - Structural

- The Body contains MANY important structural proteins that provide support, structure and organization to our body's tissues, such as:

- **Collagen:** The most abundant protein in mammals, providing support and strength to the body's connective tissues, including the bones, tendons and dermis of the skin.
- **Elastin:** Provides stretch and recoil in CT
- **Keratin:** Provides structure, protection & some waterproofing in our skin, hair & nails
- **Actin, Myosin & Other Muscle Proteins**
- **Tubulin:** The major protein in the cell's cytoskeleton
- **Fibrinogen:** The protein that forms the skeleton of a blood clot

Important Body Proteins - Transport & Storage

- ***Important Transportation Proteins***:
- **Cell Membrane Transport Proteins-** make up the ion channel and “pump” type structures for transport across the cell membrane
- **Hemoglobin/ Myoglobin -** Oxygen transportation in the bloodstream or muscle tissue
- **Albumin -** The most abundant protein in the plasma, it helps transport many substances, including fatty acids, some hormones and some vitamins.

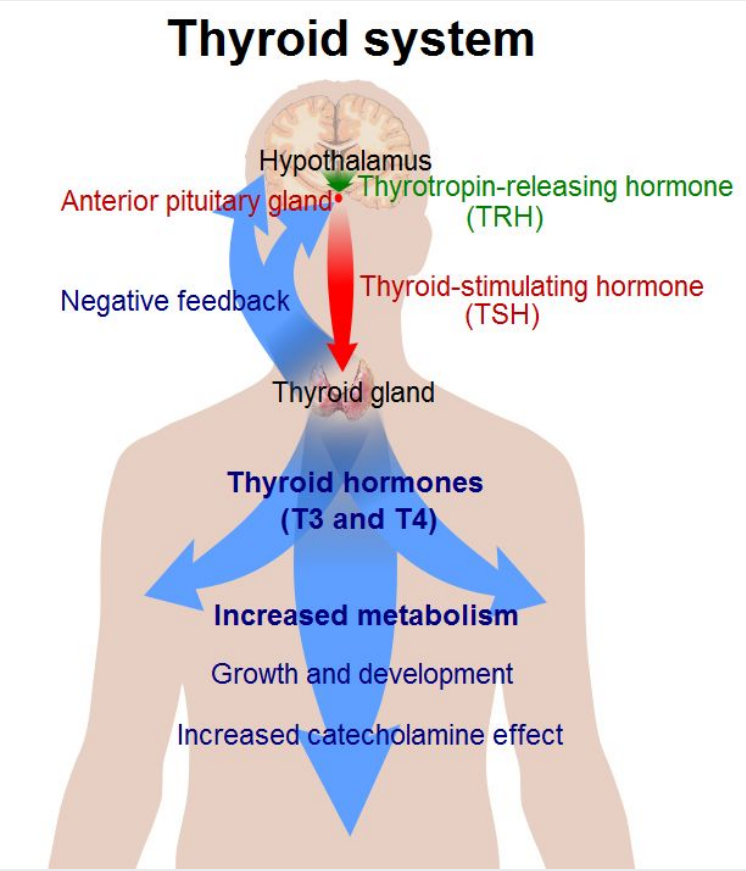
Important Storage Hormones:

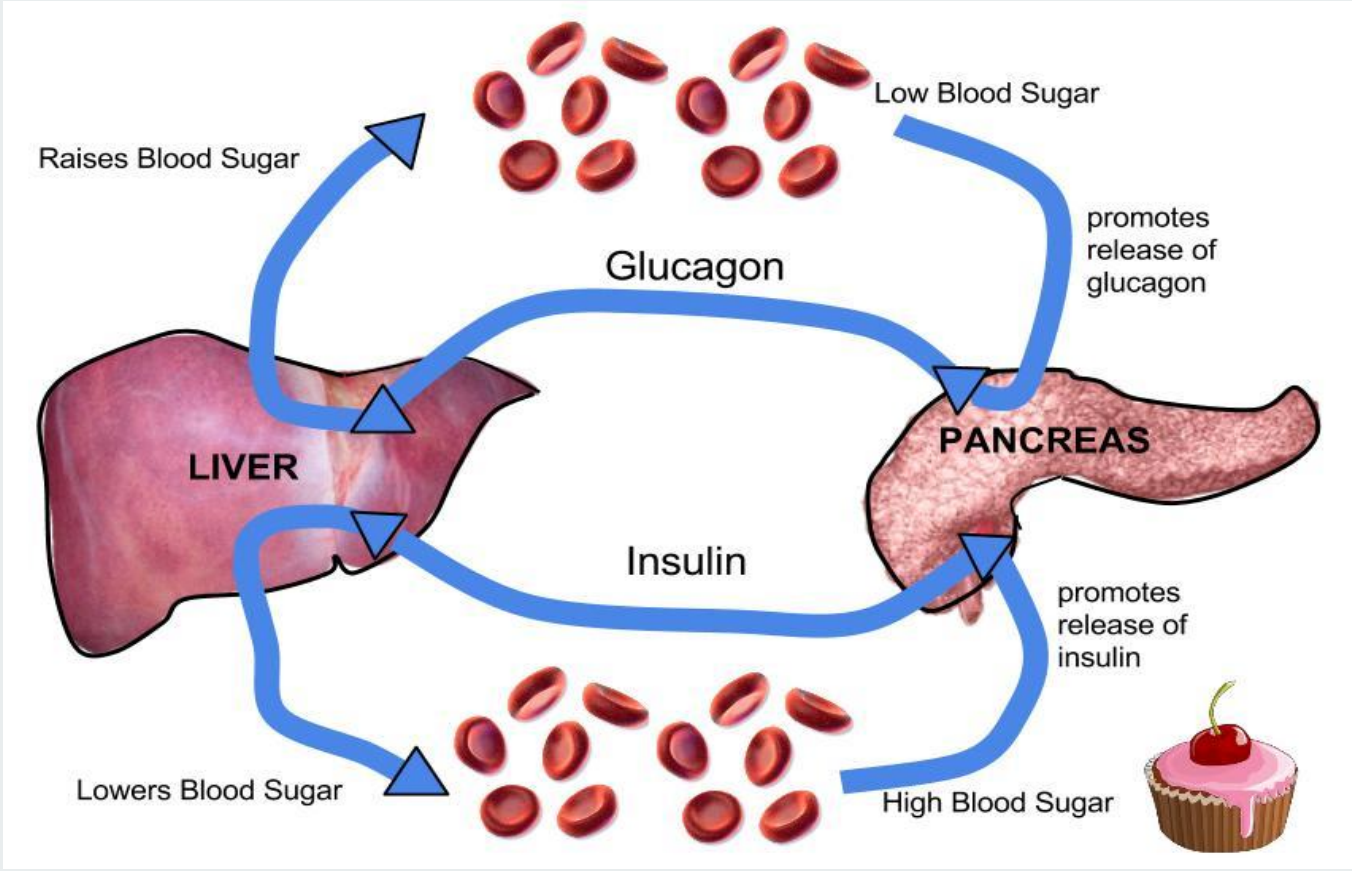
Ferritin - binds to Iron, helping to store it for when needed

Casein - A protein found in mammal’s milk, rich in amino acids

Important Body Proteins - Hormones

- **Hormones** (recall some hormones are made from lipids)
  - Eg: Thyroid hormone, insulin, glucagon





Important Body Proteins - Other Messenger Molecules

Neurotransmitters

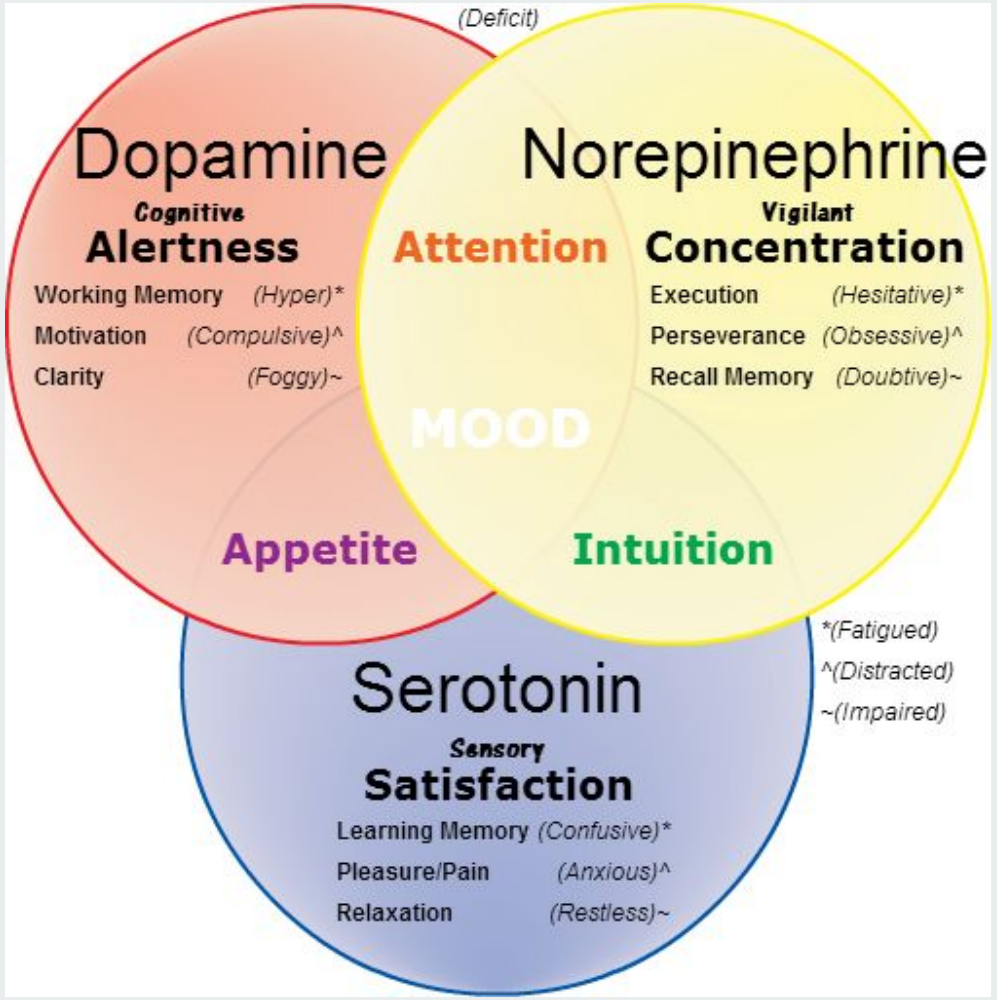
- Single amino acids, peptides or proteins may act as Neurotransmitters

Ex. Serotonin – “feel good” chemical in the brain – antidepressant medications increase serotonin levels circulating in the brain.

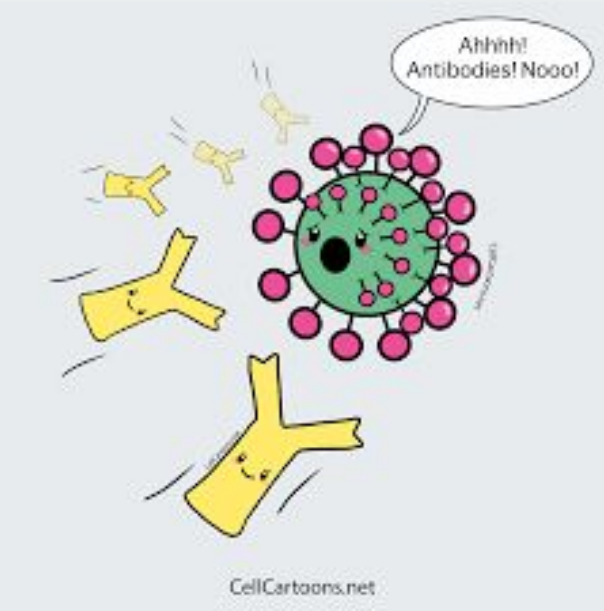
- Made from tryptophan
- Cashews also increase serotonin b/c they are rich in tryptophan

Cytokines - messengers that primarily affect the immune system & process of inflammation

Growth Factors



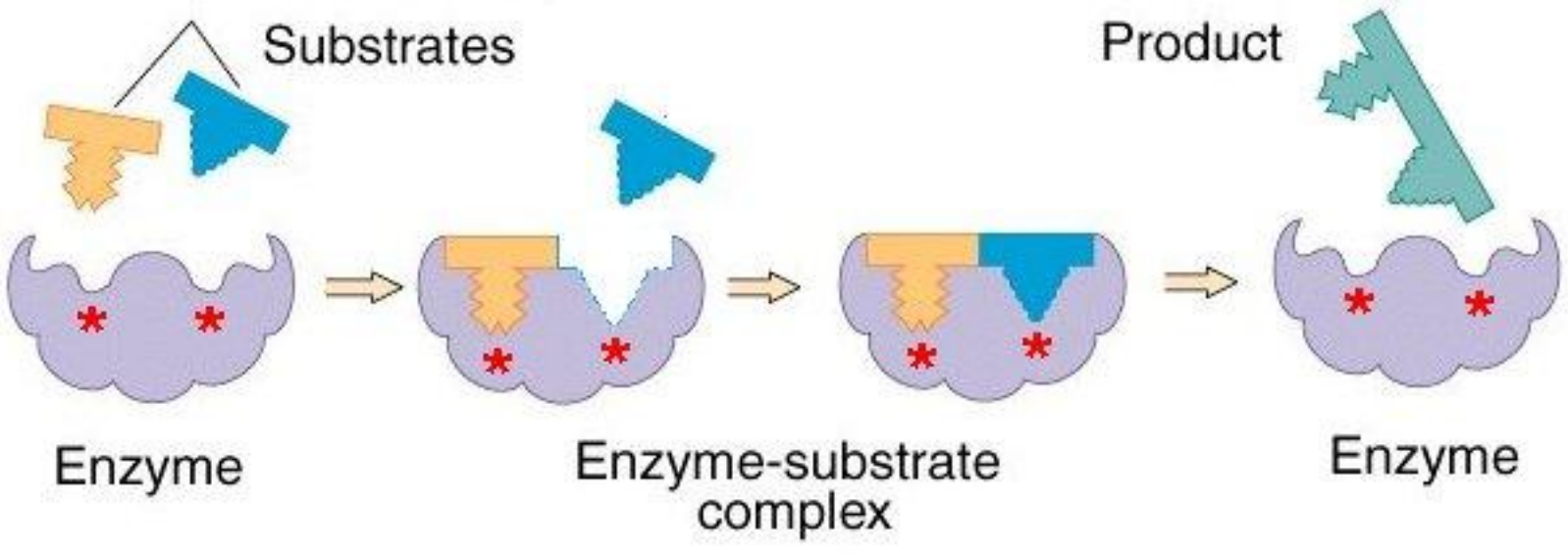
Important Body Proteins



- **Antibodies**
  - Formed by the B Lymphocytes (a type of White Blood Cell)
  - Recognize every protein that belongs within the human body and leaves these alone
  - Identifies foreign proteins that invade the body and attack them (bacteria, virus, toxin)
  - When antibodies go “bad”:
    - Hyperactive response – allergies develop (trees, grasses, molds, dust, animals, foods)
    - Autoimmune diseases – body begins to attack proteins that are “normal” within the body – this is an abnormal process

Important Body Proteins - Enzymes

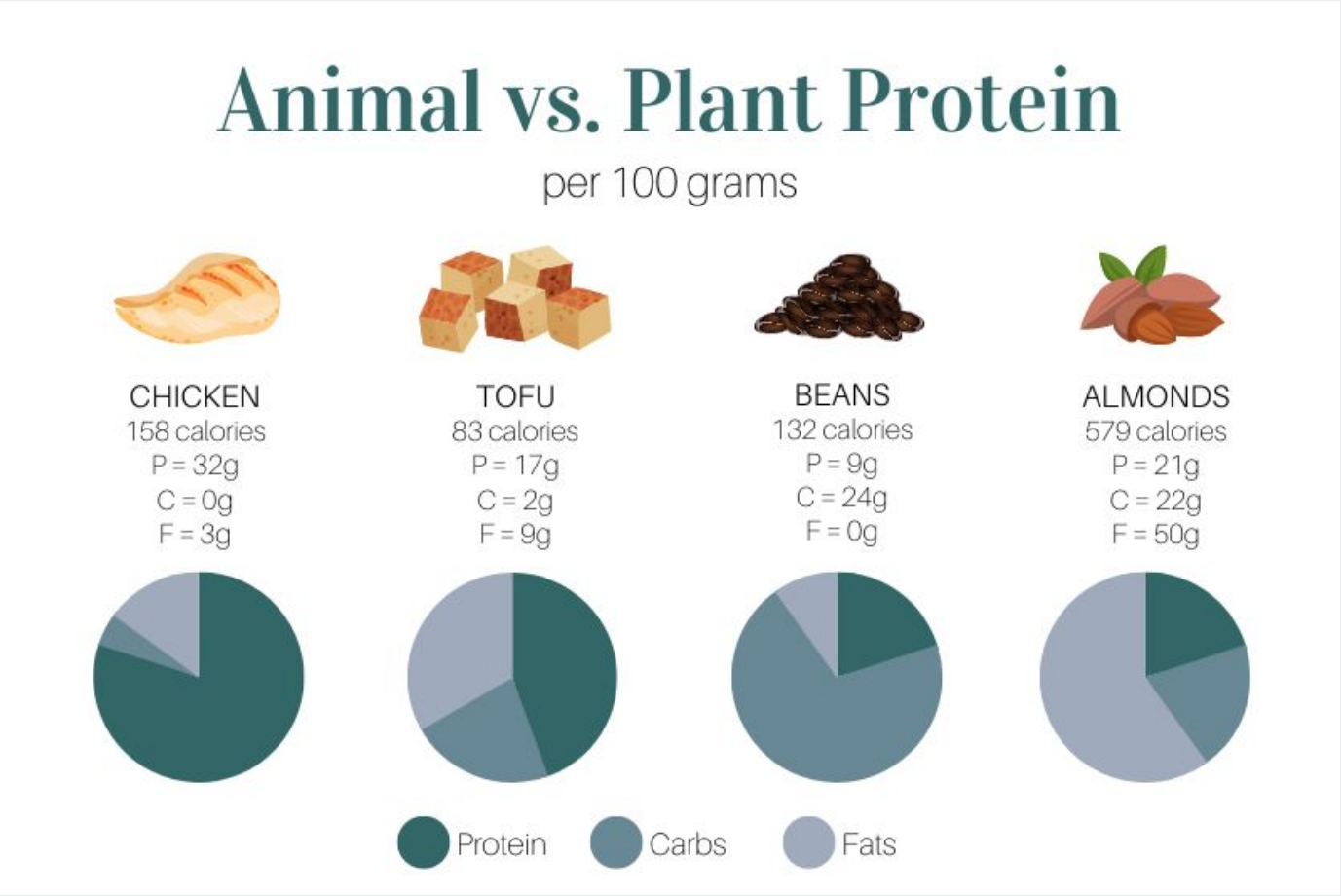
- **Enzymes -** There are many enzymes in the human body that carry out thousands of chemical reactions.



https://youtu.be/7gK-5tLFM50

Food Sources of Protein

- **Digestibility**
  - Animal protein is highest
  - Legumes (beans/lentils) – 80-90%
  - Grain and other plant sources – 70-90%
  - Cooking with moist heat increases
  - Dry heat decreases

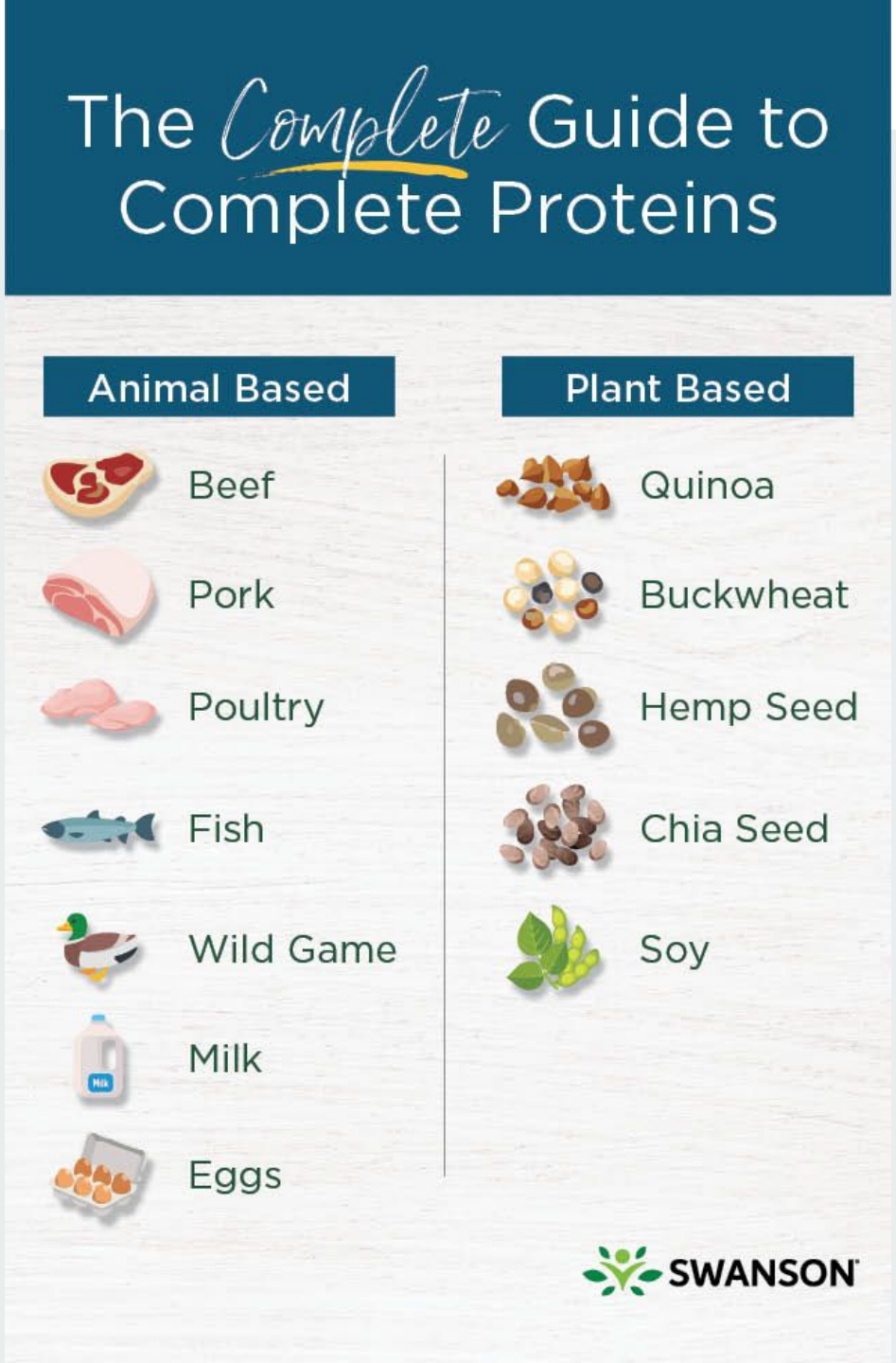


Complete vs Incomplete Proteins

A food that contains all 9 essential amino acids is called a **complete protein.**

In general, proteins from an animal source such as meat and dairy are usually complete proteins, while many plant proteins can be lacking one or more essential amino acids.

This is one reason why vegan protein powders are usually composed of a blend of plant sources.



Protein Requirements

- EAR -0.6g/kg body weight (remember: half the people will become deficient)
- **DRI – 0.8g/kg of body weight**
- AMDR - 10- 35% of total calories (1.05 - 3.67g/kg body weight)

Level of Activity	Recommended Daily Protein Intake
Sedentary Adults	0.8 g/kg
Active Adults (e.g. recreational athletes not in training)	0.8-1.0 g/kg
Endurance Athletes	1.2-1.4 g/kg
Ultra-endurance Athletes	1.2-2.0 g/kg
Strength Athletes	1.6-1.7 g/kg

Too much protein is toxic?

For many years, eating too much protein was considered potentially dangerous, especially regarding kidney function. In recent years, research is showing no correlation between kidney stone formation & kidney function in those consuming 20 -30 % of their calories from protein sources without pre-existing kidney disease.. Many nutrition scientists are now recommending eating protein levels above the DRI level & replacing nutrient poor carbohydrates & saturated fats with increased proteins.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5347101/#:~:text=The%20Acceptable%20Macronutrient%20Distribution%20Range%20(AMDR)%20(10%E2%80%9335,than%20that%20of%20the%20RDA.
https://brighterworld.mcmaster.ca/articles/myth-busted-researchers-show-that-a-high-protein-diet-does-not-affect-kidney-function/

Protein Deficiency diseases = Kwashiorkor and Marasmus

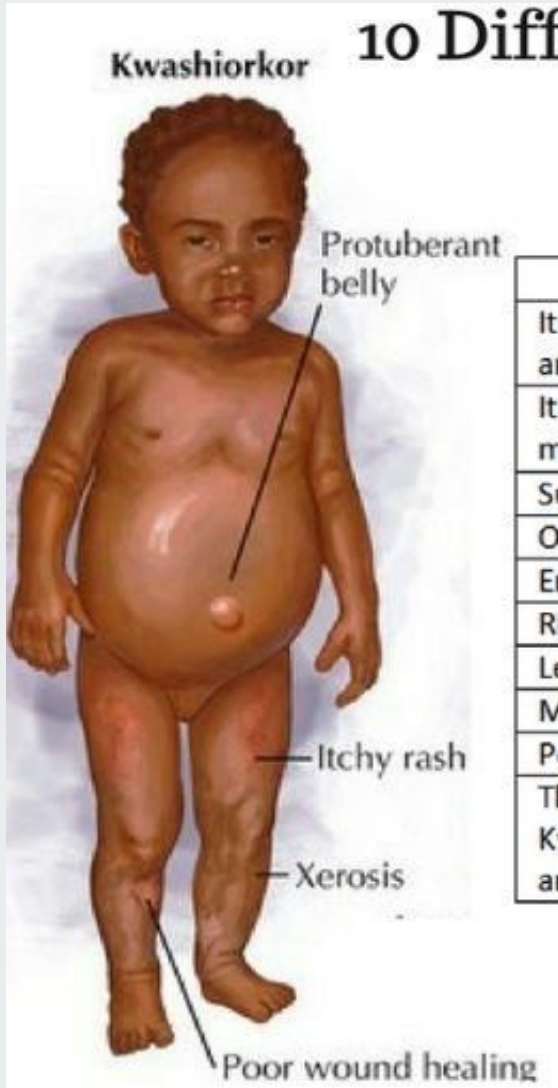
10 Differences between Kwashiorkor and Marasmus

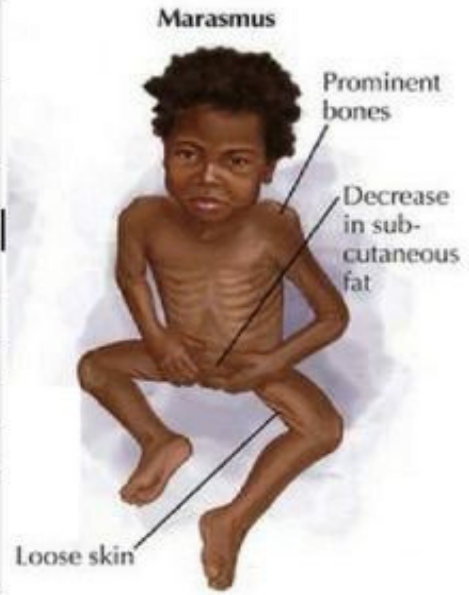
www.majordifferences.com

MD

Comparison Table

Kwashiorkor	Marasmus
It develops in children whose diets are deficient of protein.	It is due to deficiency of proteins and calories.
It occurs in children between 6 months and 3 years of age.	It is common in infants under 1 year of age.
Subcutaneous fat is preserved.	Subcutaneous fat is not preserved.
Oedema is present.	Oedema is absent
Enlarged fatty liver.	No fatty liver.
Ribs are not very prominent.	Ribs become very prominent.
Lethargic	Alert and irritable.
Muscle wasting mild or absent.	Severe muscle wasting
Poor appetite.	Voracious feeder.
The person suffering from Kwashiorkor needs adequate amounts of proteins.	The person suffering from Marasmus needs adequate amount of protein, fats and carbohydrates.





Kwashiorkor vs Marasmus

Dietary Macronutrient Review

Carbohydrates - Composed of C,H & O elements.
Types produced by plants include: Fibre, starch and sugars.
Type produced by animals (incl. humans) is Glycogen.

RDA of 130g/day based on brain's needs.
AMDR (Acceptable macronutrient distribution range) is 45- 65% of total calories. For 2000 kcal/day this works out to be 225 - 325g/day

BUT recall that people can survive on <20 g per day (Brain will get energy from ketone bodies instead)

AI for Fibre is 21 - 38 g/day for adults, varying according to age and sex.

Dietary Macronutrient Review

Lipids (AKA Fats)- Composed of C,H & O elements.
Includes polyunsaturated, unsaturated & saturated fats.
Different structural forms include: Triglycerides, Sterols & Phospholipids

Adequate Intakes are only established for:
Linoleic Acid (Omega 6) of 11 - 17g/day and
Linolenic Acid (Omega 3) of 1.1- 1.6g/day, depending on sex and age.

AMDR for percentage of calories from fat is 20 - 35%.

Dietary Macronutrient Review

Protein - Composed of C, H, O & N elements

RDA is 0.8 g /kg body weight for the majority of adults.
AMDR is 10 - 35% of total calories.

Deficiency of protein specifically is called Kwashiorkor.

No Upper Limits (UL)s are defined for any macronutrients.

Macronutrient Ratios for Specific Goals

Tracking your macros can be an effective way to work towards specific goals. Some specific ratios, based upon nutritional science are:

For weight/fat loss: 50% C:35%P:15% fat
Or 10% C: 20% P: 70% F (keto)
Muscle building: 30%C: 40% P: 30% F
For ”cutting”: 25%C: 35% P: 40% F

“Standard”: 45 - 65%C:10 - 35%P: 20 - 35%F
AMDR

Resources

1. https://www.mdpi.com/journal/nutrients
2. https://www.canada.ca/en/health-canada/services/nutrients.html
3. https://pmc.ncbi.nlm.nih.gov/articles/PMC1479724/#:~:text=Dietary%20reference%20intakes%20suggest%20that,to%20meet%20their%20unique%20needs.
4.