**Aunt Cathy’s Guide to Nutrition:**

**Amino Acids and Protein**

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**Structure**

Structure of an amino acid: $R - N - C - COOH$

N = Nitrogen (NH$_3$ & 4) ammonia  C = Carbon
COOH = acid end, made out of carbon, hydrogen and oxygen (“carboxyl group” – “boxcar”)
Metabolic by-products = energy, CO$_2$, water & N

Structure of Proteins = chains of AAs held together by peptide bonds
Short chains (e.g. 2-6 AAs)= peptides  Long chain = protein. Most proteins are over 50 AAs long.
All proteins contain all 20 AAs., but collagen is odd.

<table>
<thead>
<tr>
<th>Primary Structure</th>
<th>Number of each AA present in the mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Structure</td>
<td>Order of the AAs strung together on a chain. Example of a problem when one AA is in the wrong place on the chain: Sickle cell anemia.</td>
</tr>
<tr>
<td>Tertiary Structure</td>
<td>Shape of the molecule due to certain AAs attracting or repelling each other. Sickle cell anemia: the problem at the Secondary level causes problem at this level: the shape of the red blood cell is not round but is sickle-shaped and easy to break. Shape is also important in allergy – the immune system recognizes proteins by their shape and reacts to it.</td>
</tr>
<tr>
<td>Quaternary Structure</td>
<td>Some proteins contain more than one protein chain. Examples: Insulin and Hemoglobin.</td>
</tr>
</tbody>
</table>

**Things made out of protein**

Muscles and other body tissues,
Some hormones (like insulin and glucagon)
Albumin (a carrier protein +oncotic pressure)
Hemoglobin (a carrier made of 4 protein chains with iron in the center: carries O2 to tissues)
Ferritin (an iron-storage protein)
Transferrin (a carrier protein for iron)

Enzymes,
Immune Antibodies,
Collagen (connective tissue)
Markers of protein status: Albumin, Transferrin,
Pre-albumin, C-Reactive Protein in blood
“Buffering” activity to maintain appropriate body pH (alkalinity and acid)

**Things made out of Amino Acids and Peptides**

Neurotransmitters (e.g Dopamine, Norepinephrine, Serotonin, Melatonin)
Example of a problem: Inadequate production of dopamine results in parkinsonism
Example of a problem: PKU (Phenylketonuria) – can’t get rid of excess phenylalanine, an essential amino acid. Without a very special diet, mental retardation develops. With careful diet: normal development.

**Vegetarianism issues**

<table>
<thead>
<tr>
<th>Complementary proteins</th>
<th>Macrobiotic Diet</th>
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</thead>
<tbody>
<tr>
<td>“Limiting Amino Acid”</td>
<td>Vegan</td>
</tr>
<tr>
<td>Omnivore</td>
<td>Lacto-vegetarian</td>
</tr>
</tbody>
</table>
Lacto-ovo-vegetarian
Grains --- Lysine is limiting AA
Legumes (beans)—Methionine is limiting AA
Essential AAs
Non-Essential AAs
Conditionally Essential AAs
Amino Acid Pool -- Do we have protein stores?

Using protein and Amino Acids for energy

Is protein the body’s preferred source of energy?
How about in athletes?
Excretion of N waste product
Urea / BUN
Liver & kidney role in N excretion
Hyperammonemia
“Draw a star” test
Delirium Tremens
Hepatitis / Fatty liver
Cirrhosis of the liver

HBV - High Biologic Value (amino acid content well-suited to make human tissue): best = egg; meat and milk next best.
LBV – Low Biologic Value (amino acid content not as well-suited to make human tissue; need more quantity to make up for poor quality, and more AA waste produced): plant proteins

Protein Score        PDCAAS

Alcoholism
Regeneration potential of the liver
Effect on kidneys of chronic high protein intake
Increased water requirements with high N waste.
“Atkins” /Ketogenic-type diets for healthy adults
Ketogenic diets for seizure control.
“Carbon skeleton”
“Protein Sparing”
Renal Solute Load
4 kcal/g

Protein /Calorie Malnutrition (PCM)

Kwashiorork – Second Child Disease     Marasmus
Aflatoxin mold on Peanuts        Dysentery
Flaky Paint, Flag Sign          Edema
If protein ok but calories are inadequate, the protein will be burned for energy instead of using it for growth or body repair … because the body’s first need is for energy!
Nitrogen Balance (N in = N out)        Gluconeogenesis
Homeostasis (Maintaining all systems within the normal ranges.)
Anabolism (Take in more N than you excrete in urine: growth, pregnancy, muscle building, etc.)

A = Add + metabolism
Catabolism (Excrete more N in urine than you take in: trauma, inadequate kcals, illness, etc.)
C = Catastrophe + metabolism

Protein requirements: World Health Organization (WHO) : Adults need 0.8 g protein per kg body weight
Practical interpretation: 1 g/kg  (1 kg = 2.2 lbs) Babies need twice as much, pound for pound (about 2 g/kg) because of growth. They double their birthweight by 6 mo, and triple it by 1 yr. What would happen if you doubled your present weight by 6 months from now? [Note: The WHO recommended minimal levels of protein are about to be increased because it appears that this intake level is not adequate.

If protein is consumed in amounts above a person’s requirement, it will be converted to glucose and/or fat.

Allergy issues:

Immunoglobulin E          Anaphylaxis (Celiac Disease)
Hypoaalergenic            “Gut permeability” GI villi damaged from wheat,
Protein shape              Gluten-sensitive enteropathy rye barley + other effects

Digesting protein

“Denatured”—acid, heat, enzyme action, manipulating, etc.
Why can’t a person take insulin orally?
Immune system

Pancreatic Proteases and Peptidases, absorption in the small intestine. Absorption onto the portal circulation (blood heading toward the liver) “Curds and Whey”