

**ENSC 315 Lecture 2. 2005 Gene Donefer**

- **Food security** (UN FAO World Food Summit, 1996)...
- 'food security exists when all people, at all times, have physical and economic access to sufficient, safe and **nutritious food to meet their daily needs** and food preferences for an **active and healthy life**'.
- **Food supply** – (expressed as total or per capita) must be related to (1) **human nutrient needs**, (2) **nutrient content of foods**, (3) **systems of food production and food processing**.

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Presentations on **NUTRITION** deal with basic aspects of ("**normal**") **nutrition** and effects of improper nutrition: **malnutrition**.

- Nutritional components of foods include: **carbohydrates, proteins, fats, minerals and vitamins**
- Nutrient components serve as
  - (1) source of dietary energy – non-specific,
  - (2) specific need for "essential amino acids" (proteins) and "essential fatty acids" (fats),
  - (3) very specific role of minerals and vitamins.
- **Malnutrition**: nutrient deficiency (or surplus) result in pandemic disease situations (Lecture 3)

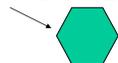
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**BASIS OF AGRICULTURE and FOOD PRODUCTION:**

RELATIONSHIPS BETWEEN:  
SUN/ WATER/ SOIL/ PLANTS/ ANIMALS

Precursor of all life – capture of solar energy (source of all global energy) = **PHOTOSYNTHESIS**

carbon dioxide (CO<sub>2</sub>) + water (H<sub>2</sub>O)  
+ solar energy (via) chlorophyll (in plant cells)  
= **CARBOHYDRATE (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>) + oxygen**



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Basic **carbohydrate** unit is the monosaccharide **glucose (C<sub>6</sub> H<sub>12</sub> O<sub>6</sub>)**

...which is also transformed into other **plant components**: sugars, starch, cellulose (fibre), fat , and proteins (+ N, S)

...plant cells also contain:  
mineral (inorganic) elements (i.e. P, K, etc)  
**and much water** (about 90% of content of living organisms)

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**Classification of carbohydrates\***

**Saccharides (sugars): only 6**

Mono... → **glucose / fructose / galactose**

Di... → **sucrose** (glucose + fructose)

→ **lactose** (glucose + galactose)

→ **maltose** (glucose + glucose)

**Complex carbohydrates:**

**polymers (chains) of glucose molecules:**

→ starch | same polymer, but  
cellulose | different "linkage"

→ hemicelluloses (C<sub>5</sub>, present in fibres)

[Reference; Nestle, Table 3-1]

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**ANIMAL UTILIZATION OF CARBOHYDRATES**

**STARCH** easily digested by enzyme **AMYLASE**, present in saliva and stomach (G.I.\* tract) of all animals. Starch primarily present in plant **seeds** and **some roots** (potatoes, cassava...), as plant's storage form of energy.

As plant seeds and roots are only a small portion of total plant material (which is primarily stems and leaves) – dietary intake of starch was limited by availability (particularly in "hunter-gatherer" societies).

Major effect of **development of agriculture** (starting 10,000 years ago) was to **increase dietary starch supply** (through cereal grains and potatoes). **SUGAR** has only become a significant part of human diet in last 2-centuries

\*gastro-intestinal

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**NUTRITIVE AVAILABILITY TO ANIMALS (INCLUDING HUMANS) of ...CELLULOSE.**

**MOST ABUNDANT PLANT CONSTITUENT**, as part of structure of stems, leaves;  
 almost always in association with lignin (lignin is not digestible) – and is responsible for plant rigidity.  
plant maturity (ligno-cellulose complex) determines cellulose availability (extent of plant lignification): increases from annual to perennial “woody” plants (i.e. trees: paper-making is process of delignifying wood).

**BUT.... ONLY HERBIVORES HAVE EVOLVED DIGESTIVE SYSTEMS TO UTILIZE “CAPTURED” ENERGY OF CELLULOSE**  
 ... DIGESTED BY ENZYME CELLULOSE OF BACTERIAL ORIGIN (in intestinal tract of RUMINANTS, OTHER HERBIVORES (and even some insects, i.e. termites). 7

**Nutritive value of “forages”** for herbivores/ruminants related to extent of plant lignification:  
 young pasture grasses: good value  
 dead stems (“straw”) : poor value

**Quantity and quality of “forages” in herbivores diet related to animals nutritive requirements:**

slow growth and mature state (i.e. beef cows, sheep): all-forage diet: pasture, range (grazing), hay.

fast growth (feedlot beef), high lactation (dairy cows): Forage + grain supplements: livestock genetic improvement over past centuries, has increased production potential and thus supplementary feed requirements.

Note: increasing research on delignification methods (i.e. alkali and other treatments) to improve feed quality of low-quality forages (straws, sugarcane bagasse, even wood). 8

**Non-herbivores** (simple stomach) particularly omnivores (humans, pigs, rats...), have a limited ability to utilize cellulose, due to presence of “favorable” bacteria in G.I. Tract (caecum, colon).

Current recommendation to increase dietary fibre (cellulose and hemicelluloses) intake in human diet is not related to nutritional contribution of fibre (which is minimal), but to physical effect in G.I. tract:

- (1) speeds food passage – reduces bowel cancer.
- (2) as precaution against obesity (fibre dilutes high-energy density foods – starches, sugars, fats).

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**HUMANS CONSUMING ANIMAL PRODUCTS (MEAT, MILK) FROM HERBIVORES - ARE INDIRECTLY UTILIZING CELLULOSE** (and other plant constituents) from “primary animal harvesters”.

**Non-herbivores** ( pigs, chicken) also produce protein-rich foods (meat, eggs), but consume diet similar to humans -therefore “competitive”

**Other considerations:**  
 “animals as human foods” as related to  
 (1) human evolution, and  
 (2) necessity of animal derived foods in human diet (vegetarianism, particularly “vegan”? 10

**PLANTS UTILIZE SOLAR ENERGY AND CHEMICAL ELEMENTS (C,H,O,N,P,S) TO SYNTHESIZE...**

↓

	which animals digest & absorb to...
CARBOHYDRATES	→ glucose
PROTEINS	→ amino acids
FATS	→ fatty acids

all of these absorbed compounds are used by the body as NON-SPECIFIC SOURCES OF ENERGY  
 BUT... ESSENTIAL AMINO ACIDS (eaa's) and ESSENTIAL FATTY ACIDS (efa's)  
 have specific functions, and are dietary requirements 11

• **DIFFERENCES BETWEEN PLANTS AND ANIMALS:**

- Plants capture solar energy → **PHOTOSYNTHESIS**
- Animals obtain energy from eating plants (by reverse reaction of photosynthesis) = **RESPIRATION**

**GLUCOSE + H<sub>2</sub>O = H<sub>2</sub>O + CO<sub>2</sub> + ENERGY**

Starch and cellulose are present in plants but “never”\* as animal components.

\*exception: the only carbohydrates present in animals is (blood) glucose and an intermediary storage form – glycogen (both serve a critical role in animal metabolism) 12

ABSORBED **AMINO ACIDS** ARE USED BY ANIMAL CELLS TO SYNTHESIZE **PROTEINS** (muscles, organs, enzymes, fetus, milk protein.)

There are 20 different a.a.'s, of which 10 are **dietary essentials (eaa's)**, the other 10 can be synthesized in the body (non-dietary essential)  
[reference: Nestle. Table 5-1]

**"PROTEIN QUALITY"** ... is defined as the number and amount of **essential amino acids** (e.a.a.'s) in a protein.

**PLANT PROTEINS** are low to medium quality ... the only exception being soybean protein = high  
**ANIMAL PROTEINS** are always high quality (complete proteins).

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**OMNIVOROUS ANIMALS** (Humans, pigs, ...) **REQUIRE HIGH QUALITY DIETARY PROTEIN**, especially for critical life periods – infants, young children (growth) gestation, lactation.

This is obtained from milk by infants and later eating animal & plant food combinations.

Children eating only plant proteins – from cereal grains or roots – results in poor growth (malnutrition),

... when these grains are consumed in combination with leguminous seeds, the mixture is of higher protein value than either of the foods alone - (called a **"complementary protein effect."**)

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**PROTEIN COMPLEMENTARY EFFECT**  
since the limiting e.a.a.'s in cereal grains are different from those in leguminous seeds (beans, pulses), when consumed in combination the two protein sources "complement" each other so that a minimum amount of dietary protein from animal sources is needed.

.....  
examples of regional diets using this effect are:

- rice & beans (asia, americas)
- corn & beans (americas)
- wheat & beans (n.africa)

What are "limiting amino acids" in corn, wheat, soybeans? [reference: Nestle, page 23]

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**DIETARY FATS: concentrated source of food energy.**  
**Sources: plant seeds: vegetable oils**  
**animals tissues: meat, dairy foods**

Dietary fats (triglycerides) are digested & absorbed as fatty acids which are metabolized for energy, and also used for synthesis of fat-containing molecules (body tissue, milk).

There is also a dietary requirement for a small amount of "essential fatty acids," and these are related to "newly" identified health properties of "Omega 3,6,9" fatty acids (fish oils are rich source)

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Current recommendations re dietary fat supply "oversimplified" summary –  
Although fats are not dietary requirements (with exception of small amount of efa's), they constitute an increasing proportion of human diet (particularly in "rich" countries). Recommendation is that fats should constitute 30% or less of dietary energy (calories).

Other fat "facts":

- \*plant fats are unsaturated (liquid) (+)
- \*animal fats are saturated (solid), with cholesterol present, and intake should be minimized (-)
- \*tropical oils (palm, coconut) high in saturated fats (-)
- \* food processors "hydrogenate/ saturate" (+H) plant oils to produce "solid" margarine (and trans-f.a.'s) (-) 17

**CALCULATION OF ENERGY CONTENT\* OF FOODS (humans) and FEEDS (other animals)**

Components	%	kcal/g	kcal/100g	%energy
carbohydrate	74	x 4	296	80
protein	9	x 4	36	10
fat	4	x 9	36	10
minerals	1			
Water	12			
			368	100

food in above illustration = corn grain  
\*(as used on food labels and composition tables)

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