

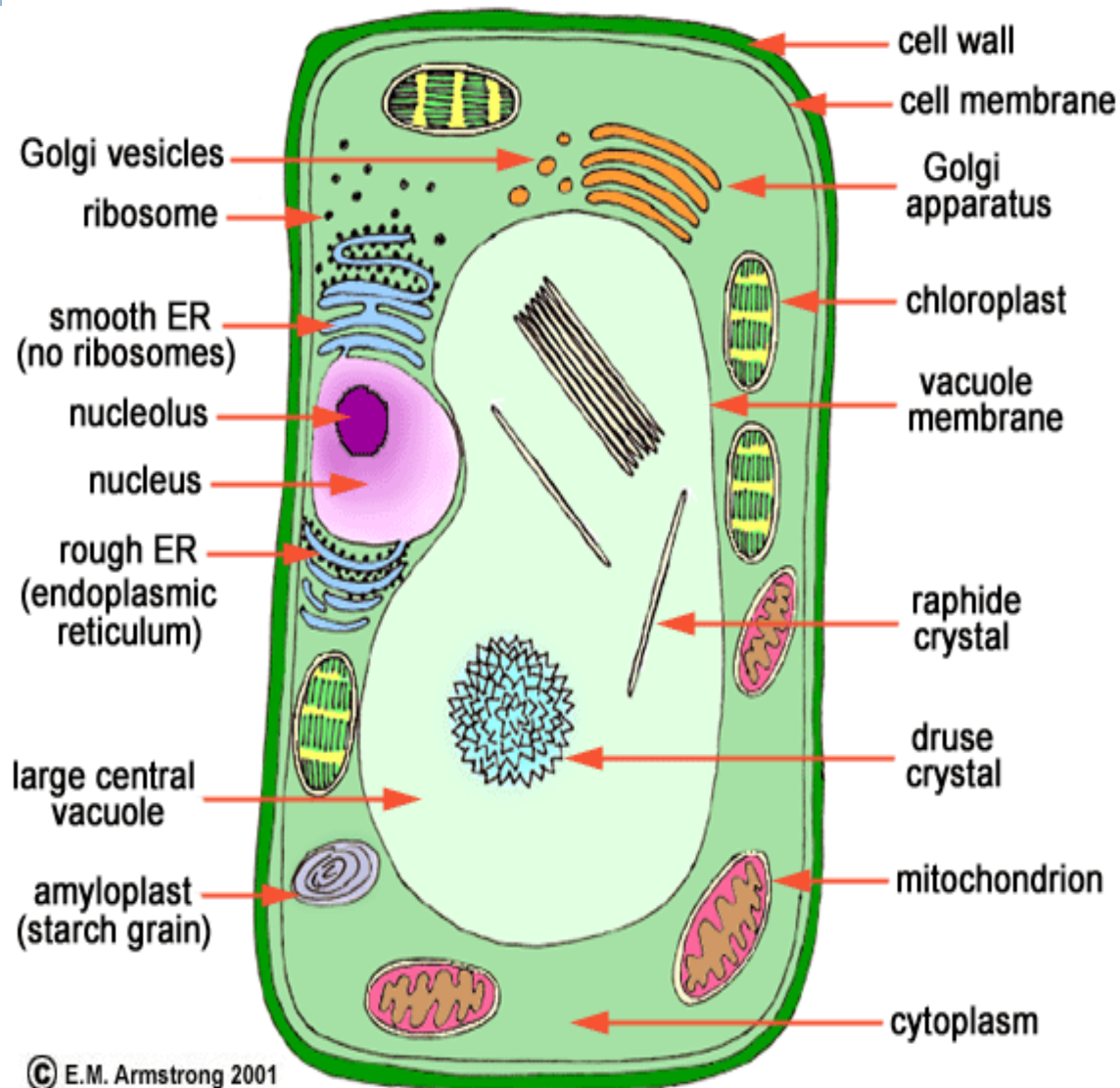
CARBOHYDRATES

Created for BCLM Pony Club Nutrition #14

Carbohydrates

- Collective term for starches, sugars and dietary fibres
 - ▣ The dietary fibres are cellulose and hemicellulose
 - ▣ Glycogen is how energy is stored in the liver and muscle
- Is instant energy for horses
- Primary energy source for horses
 - ▣ Major component of feedstuffs for horses
 - ▣ Make up 75% of the dry matter in plants
- 2 types:
 - ▣ Structural
 - Associated with plant cells (dietary fibre)
 - ▣ Non-structural
 - Associated with plant cell content
 - Simple sugars, starches, fructans
 - These are starches and water soluble carbohydrates

Plant cell



Structural Carbohydrates aka Complex Carbohydrates

- Found in hays and forages
- The plant cell wall is structural carbohydrate
- This component constitutes the fibrous portion of the plant
- Carbohydrates (CHO) are associated with the cell wall
 - ▣ Provides the plant with rigidity and strength
- Major source of dietary fibre
- Major energy source
- Digested by microbes in the large intestine

Present in Cell Wall

- Cellulose
 - ▣ The major structural component in mature plant cells
- Hemi-cellulose
 - ▣ The most digestible
 - ▣ Converts to cellulose as it matures
- Pectin
- Lignin
 - ▣ Lignin is not a true CHO, but is closely associated with CHO
 - ▣ Not readily digestible
 - ▣ No nutritive value

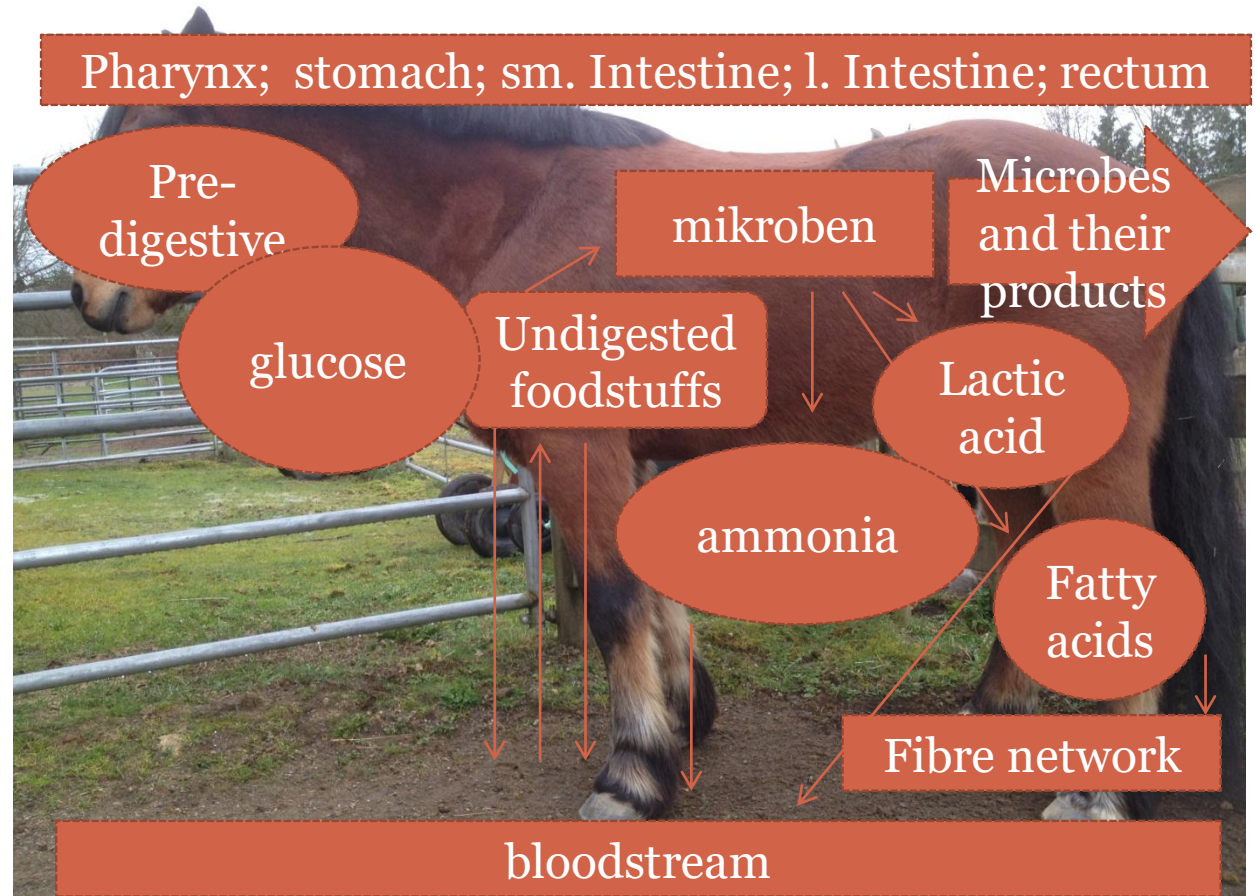
Digestion of structural carbohydrates

- Degraded by microbes in GI tract
- Not digested in small intestine
- No enzymes to break down these components
- Microbial population breaks down CHO to produce volatile fatty acids (VFAs):
 - Acetate
 - Buterate
 - Propionate
 - Absorbed across cell wall and used as an energy source
- By-products:
 - CO₂
 - methane



Enzymatic digestion takes place in the foregut (stomach and small intestine)

Microbial digestion takes place in the hindgut (cecum, small colon, large colon)



Enzymatic and microbial digestion sites

Lignin

- Lignin is not a carbohydrate
- It is a component of cell wall
- Grass, hay, straw, sugar beet pulp are high in fibre
- Lignin is negatively correlated to digestibility
 - ▣ As plants mature, lignin increases to provide plant with strength and rigidity
 - ▣ This reduces digestibility
 - ▣ It lowers the nutritive value of the plant
 - Therefore, the more mature the plant = the lower the digestibility due to more lignin



Protein suggestibility

- Also affected by lignin deposition:
 - ▣ Protein suggestibility
- Proteins associated with cell wall are reduced in digestibility as lignin increases
- Therefore, the more mature a plant is, the more lignin it would have; this means protein decreases
 - ▣ Examples: hay, straw

Fibre Analysis

- Two methods:
- 1. Measure the total cell wall content
 - Measure *Nutrient Detergent Fibre* content
 - Amount of hemi cellulose, cellulose and lignin present in the plant
- 2. Measure the fraction of plant that is less degradable
 - Measure *Acid Detergent Fibre (ADF)* content
 - Measures amount of cellulose and lignin
 - Higher ADF values = less degradable

Non-structural Carbohydrates

- Storage carbohydrate - Plant uses as energy source
- **Starch** is the major source of non-structural CHO
 - ▣ No more than 5%
- Found in:
 - ▣ Cereal grains
 - Between 40-70%
 - ▣ Roots and tubers
 - ▣ Forage legumes
 - ▣ Lower levels present in leaves and stems
- In temperate grasses, **Fructan** is the major non-structural CHO storage
 - ▣ Can be up to 40% of dry matter
- Located in the stem
- Made up of polymers of fructan
- Soluble in water = water soluble carbohydrate

Cereal Grains



Cracked Corn



Crimped Oats



Steam Flaked Barley

Digestion of Non-Structural CHO

- Starch digests in large intestine
 - ▣ Amylase – enzyme to break down to starch
- Simple sugars absorbed across gut wall – used as an energy source
- Horse has limited capacity to amount of starch that can be absorbed in small intestine
 - ▣ Excess to large intestine = disruption of the environment
 - ▣ Starch rapidly degraded by microbial population
- Horse lacks enzyme to break down non-structural CHO
- Fructan to large intestine
 - ▣ Degraded by microbes
 - ▣ VFAs produced and used as energy source
 - Large amounts can cause laminitis

Some of the same factors that cause colic also cause laminitis



Other water soluble CHO's

- Simple sugars

- glucose

- fructose

- sucrose

- Together these are the water soluble content of plants

Water Soluble Content Variable

- Water soluble content is highly variable
- Plant photosynthesis
- When fructan intake is higher, disorders like laminitis increase
- Water soluble carbohydrates depends on environment
 - ▣ Less sunlight = plant synthesize less = lower levels of water soluble carbohydrates

Monthly Variations

- Monthly variations are due to photosynthesis
- Highest levels of laminitis occur in May
- Plants using water soluble carbohydrates for growth
 - ▣ In later spring/early summer, decrease in grass growth = increase in water soluble carbohydrates
 - ▣ Plant still photosynthesizing fructans but not using it for growth

Variations in amount of sunlight affect carbohydrate levels



Yearly variations

- Water soluble carbohydrate accumulations depend on environment
- It can vary from year to year, depending on climatic conditions
 - ▣ Less sunlight = plant synthesizes less = lower levels of water soluble CHO

Hourly variations

- At different times of the day, grasses contain variable levels of water soluble CHO
- Dependent on differences in light and temperature throughout the day
 - ▣ Peaks in late afternoon
 - ▣ Declines at night and early morning
- High levels of light and temperature = plant actively photosynthesizing and storing water soluble carbohydrates

Questions

- 1. What is lignin?
- 2. What are non-structural carbohydrates?
- 3. What are volatile fatty acids?
- 4. Describe the hourly, monthly and yearly variations in carbohydrates one might experience if field grazing.
- 5. Describe a plant cell.
- 6. Compare and contrast the digestion of structural and non structural carbohydrates.
- 7. What are the by-products of the digestion of structural carbohydrates?