

# Equine nutrition

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THE ROYAL  
(DICK) SCHOOL  
OF VETERINARY  
STUDIES



## Nutrient digestion

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# Nutrient digestion

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## Learning Outcomes

By the end of this section you should be able to:

- Discuss the digestive physiology of the equine gastrointestinal tract and appraise its limitations in relation to nutrient digestion.



# Nutrient digestion

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## Content

- Overview of nutrients in food
- Nutrient digestion
  - Water
  - Carbohydrate
  - Protein
  - Fats and oils
  - Vitamins
  - Minerals

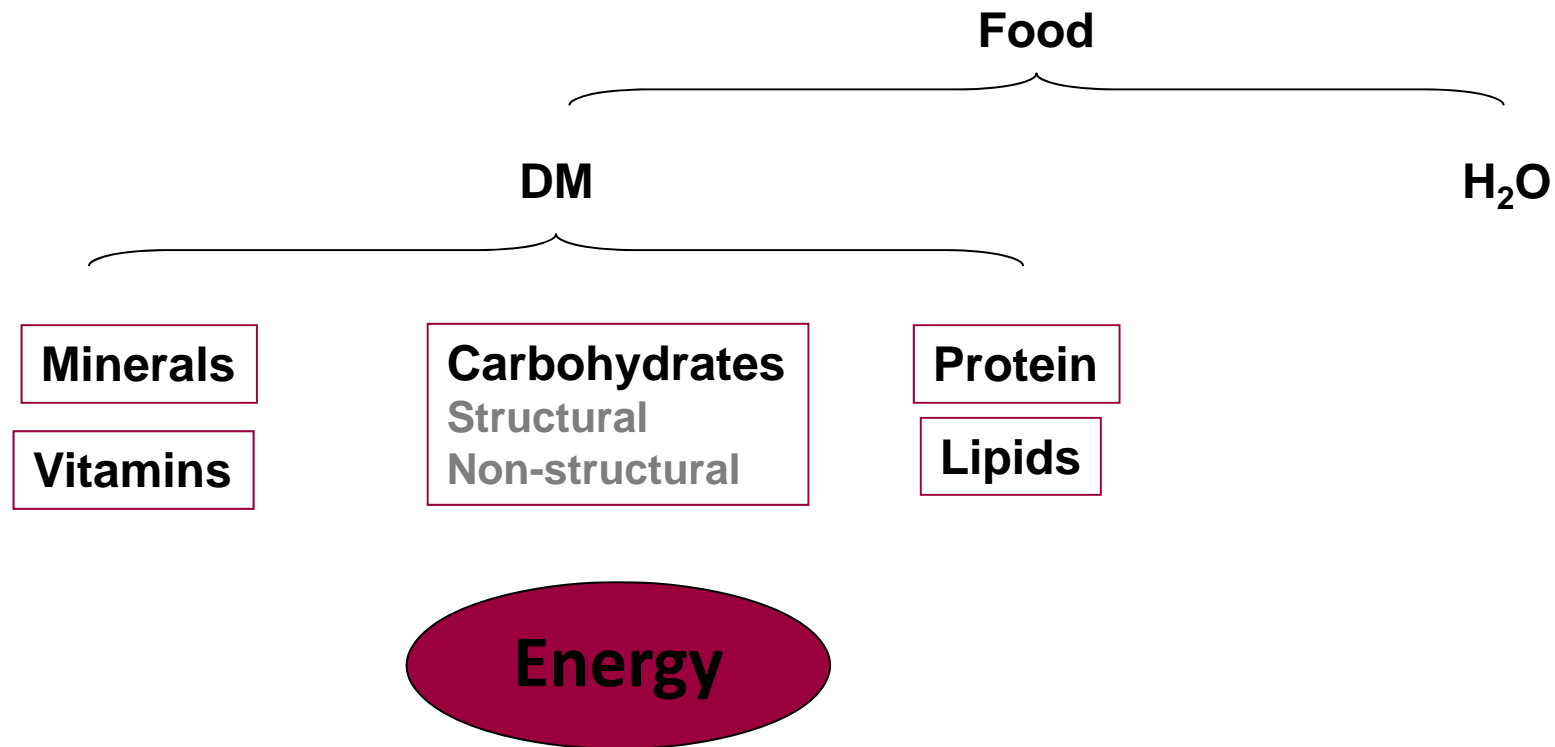


# Nutrient digestion



## What is in food?

General constituents of food:



# Nutrient digestion



## Water

- Essential component of the diet
- Water required for:
  - Transport of nutrients around the body
  - Thermoregulation
  - Metabolism
  - Excretion of waste products
  - Gut function
- 80 % of foal's BW = water
- 65 – 75 % of mature horse



# Nutrient digestion

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## Water

- Water requirements depend on:
  - Age
  - Level of exercise
  - Type of feed (horses drink ↓ on ↑ moisture diets)
  - Environmental conditions (e.g. temperature and humidity)
- **Water in food:**
  - Referred to as moisture content
  - Many horse feeds have ↑ moisture content
  - Dry matter (DM) calculated to compare nutrients

# Nutrient digestion



## Carbohydrate (CHO)

- Collective name for
  - Starches
  - Sugars
  - Dietary fibre
- CHO definitions
  - Structural (fibre)
  - Non-structural (sugar, starch and fructan)
- CHO 1<sup>o</sup> required for energy

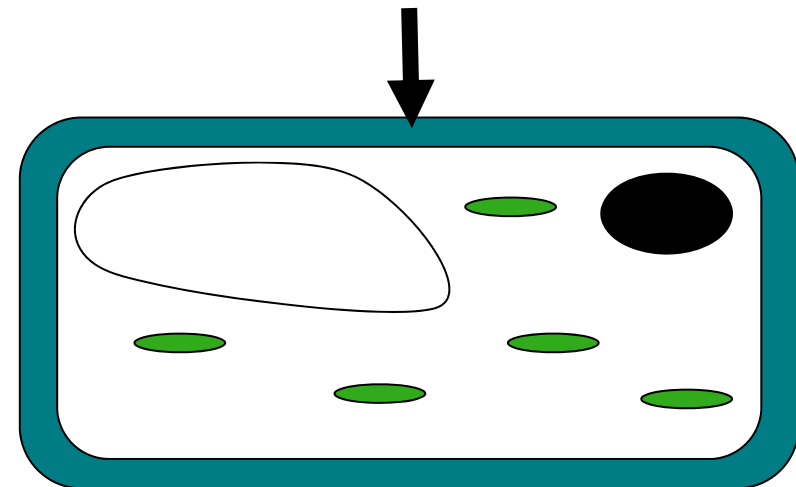


# Nutrient digestion



## Structural CHO

- Components constitute fibrous fraction of plant
  - Structural role in plants (hence name structural CHO)
  - Dietary fibre
  - Major energy source to horses
- Cell wall components
  - Cellulose
  - Hemicellulose
  - Pectin
  - Lignin



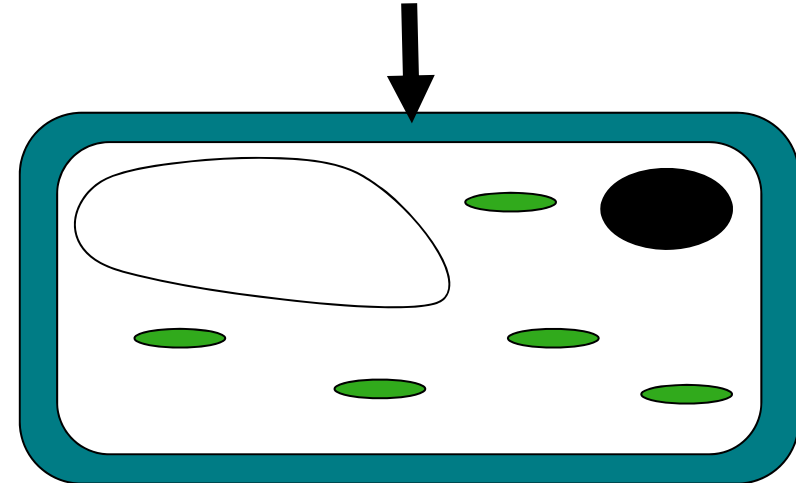


# Nutrient digestion



## Structural CHO

- Degraded by microbes in LI
  - VFA
  - Gases
  - Not digested in SI
- Feeds high in fibre
  - Grass
  - Hay
  - Straw
  - Sugar beet pulp



# Nutrient digestion

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## Lignin

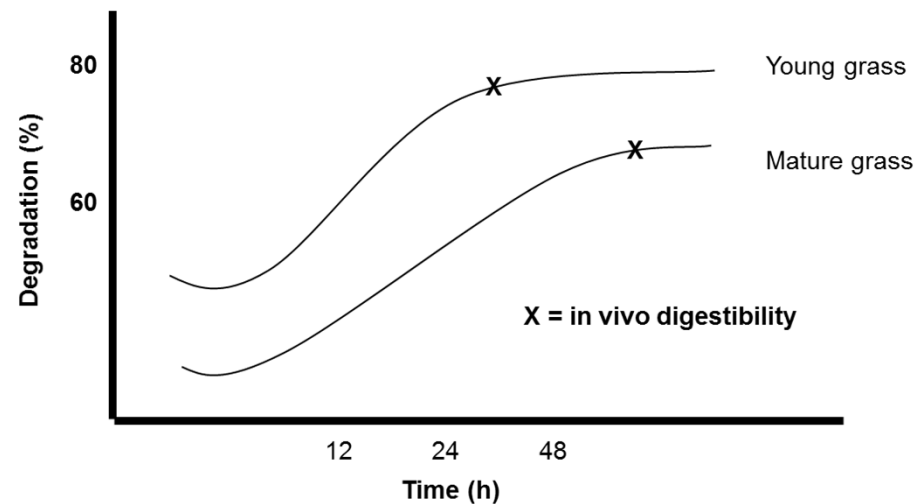
- Lignin is non-CHO monomer
- Closely associated with NSP fraction
- Negatively correlated to digestibility
  - Gives plant strength but highly resistant to chemical and microbial degradation
  - Also some plant CHO & proteins “bound” to lignin = ↓ their digestibility
- Lignin content ↑ with maturity
- Mature plants, hay and straw rich in lignin

# Nutrient digestion



## Structural CHO – Stage of maturity

- 1<sup>o</sup> factor in nutritive value of forages
- ↑ maturity = ↑ structural material (i.e. stem)
- Result = ↓ nutritive value

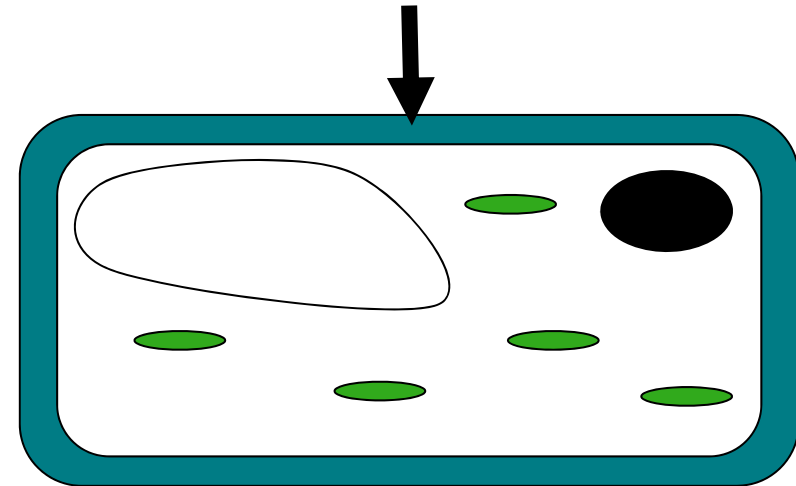


# Nutrient digestion



## Fibre analysis

- Acid detergent fibre (ADF)
  - Measures cellulose and lignin
- Neutral detergent fibre (NDF)
  - Total cell wall (including ADF fraction)

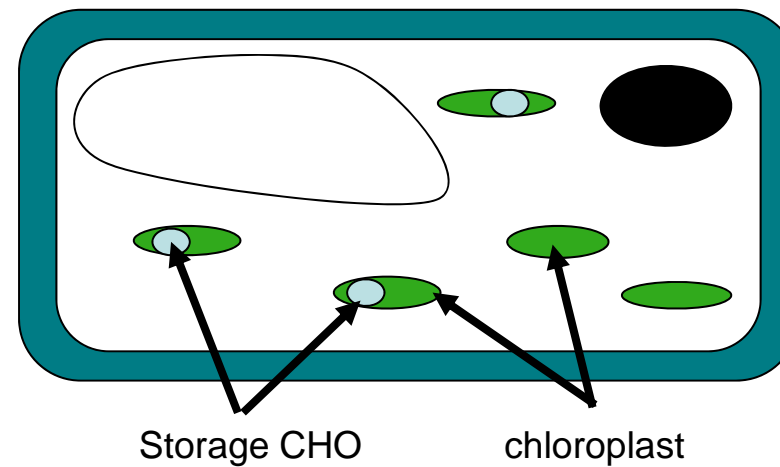


# Nutrient digestion



## Non-structural CHO

- Associated with cell contents
- Components constitute storage CHO of plant
- Storage CHO of forage crops:
  - Fructan
  - Starch



# Nutrient digestion



## Non-structural CHO - Fructan

- Major storage CHO of grasses
- Lactated primarily in the stem
- Polymers of fructose
- Soluble in H<sub>2</sub>O
- Digestion:
  - Fermented in LI
  - Horse has no enzymes in SI to break down fructose
  - Large intakes of fructan can = digestive upset (laminitis)



# Nutrient digestion

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## Non-structural CHO – WSC fraction

- Grasses also store simple sugars
  - Glucose
  - Fructose
  - sucrose
  
- Fructan + simple sugars = Water soluble CHO (WSC) fraction

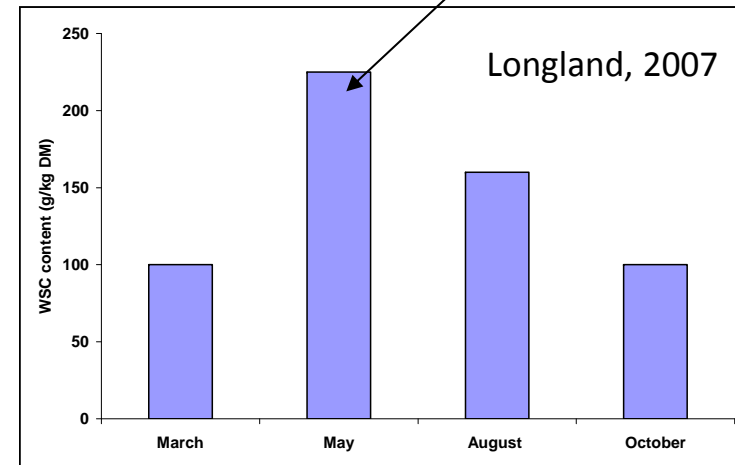
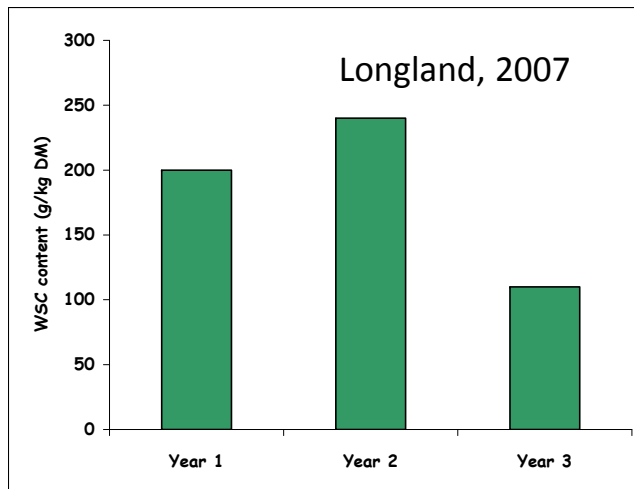


# Nutrient digestion



## WSC content of grass = ↑ variable

- **Season**
  - Early spring: ↑ growth = ↓ WSC
  - Late spring/summer = ↓ growth = ↑ WSC
  - Year effects



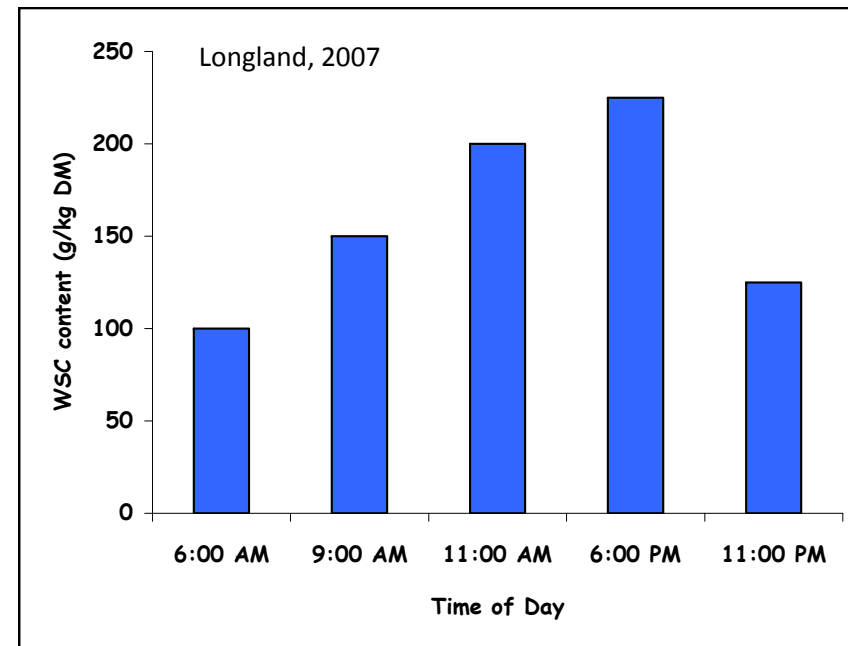


# Nutrient digestion



## WSC content of grass = ↑ variable

- **Time of day**
  - Balance b/w photosynthetic activity & utilisation
  - Affected by light & temperature
  - ↑ during the day
  - Peaks late afternoon/early evening
  - Decline during hours of darkness





## WSC – Factors affecting accumulation

- Environmental & management factors
  - Temp:  $\downarrow$  temp =  $\uparrow$  WSC
  - Light intensity:  $\uparrow$  light =  $\uparrow$  WSC
  - Water stress:  $\downarrow$  water =  $\uparrow$  WSC
  - Fertiliser application:  $\uparrow$  fertiliser =  $\downarrow$  WSC
  - Cutting/mowing:  $\uparrow$  cutting/topping =  $\downarrow$  WSC

# Nutrient digestion

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## Starch

- Major source of NSC found in many plants
  - Cereal grains
  - forage legumes
  - roots & tubers
  - Leaves and stems of grass



# Nutrient digestion



## Non-structural CHO – Starch

- Starch content varies with plant species
  - Very low in leaves and stems of grasses
  - Forage legumes = 5 % of DM
  - Cereal grains = 40 – 70 % of DM



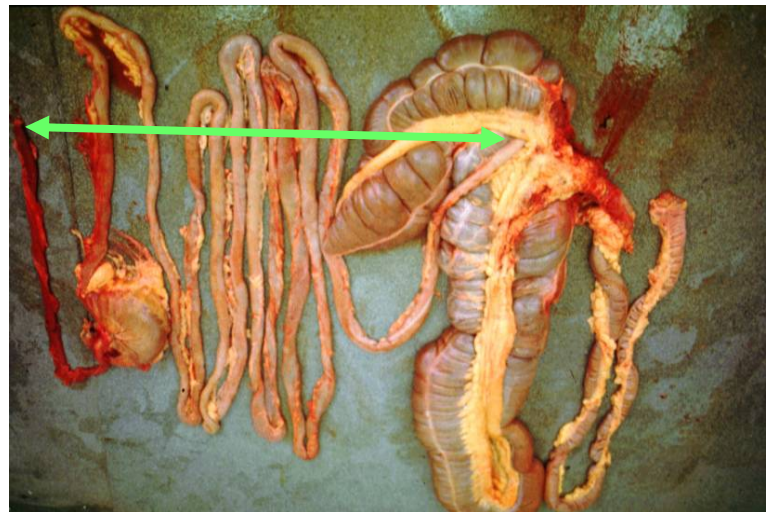
Photo courtesy of Dengie Crops Ltd.

# Nutrient digestion



## Non-structural CHO – Starch

- Digestion
  - Broken down in SI
  - Amylases break starch down to simple sugars
  - Horse can digest limited amounts of starch in SI
  - Excess travel to LI = causing disturbance



# Nutrient digestion

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## Fats and oil

- Horse diets typically ↓ in fats & oils
- Fats & oils are digested in SI by lipases
- Horse don't require ↑ levels of fat & oils in their diet
- Can add fats & oils to diet to ↑ energy content
- 2 x energy of CHO

# Nutrient digestion

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## Protein

- Required for various functions
  - Structural (e.g. muscle, skin, hair)
  - Enzymes (catalysts that affect the rate of reactions in the body)
  - Hormones (chemical messengers that regulate metabolic processes)
  - Immune compounds (for fighting infection)
  - Transport compounds (e.g. transport of nutrients)
- Consists of chains of amino acids
- Essential and non-essential amino acids

# Nutrient digestion

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## Protein

- Non-essential: synthesised by the animal
- Essential (need to be supplied in the diet)
  - Lysine (first limiting: present in the least amount relative to requirement)
  - Methionine
  - Threonine
  - Isoleucine
  - Valine
  - Arginine
  - Tryptophan
  - Histidine
  - Phenylalanine



# Nutrient digestion

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## Protein

- Protein breakdown begins in the stomach
  - Acidity denatures the proteins
  - Pepsin partially degrades proteins into smaller peptides
  - No protein absorption in the stomach
- Further broken down in SI
  - Proteases break down proteins to aa
  - Absorbed across SI gut wall
- Protein associated with the plant cell wall – fermented in LI

# Nutrient digestion



## Protein

- Protein digested in SI – used by the horse
- No aa absorption in LI
- Microbes in LI degrade protein
  - Used for microbial growth
  - No biological value to horse



# Nutrient digestion



## Minerals

- Required for various functions:
  - Growth
  - Co-factors to enzymes
  - Involved in transport of energy
- Mineral digestion:
  - Majority absorbed in SI
  - Majority of P absorbed in LI



# Nutrient digestion

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## Minerals

- Two categories of minerals:
  - Macro-minerals
  - Trace-miners
- Macro-minerals:
  - Required in relatively large quantities (g/day)
- Micro-minerals:
  - Needed in very small quantities (mg/day)
- Amounts important – also ratios of minerals (e.g. ca:p)

# Nutrient digestion



## Minerals

- **Two categories of minerals:**

- **Macro-minerals:**

- Required in g/day
- Calcium (Ca)
- Phosphorus (P)
- Sodium (Na)
- Potassium (K)
- Magnesium (Mg)
- Sulphur (S)
- Chloride (Cl)

- **Micro-minerals:**

- Required in mg/dag
- Cobalt (Co)
- Copper (Cu)
- Molybdenum (Mo)
- Zinc (Zn)
- Manganese (Mn)
- Iron (Fe)
- Fluoride (F)
- Iodine (I)
- Selenium (Se)
- Chromium (Cr)

- **Amounts important – also ratios of minerals (e.g. ca:p)**

# Nutrient digestion

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## Vitamins

- Required in small amounts – but vital for many bodily functions
  - Vision, immunity, growth, bone development, blood clotting etc etc
- Two categories:
  - Fat soluble (A,E,D,K)
  - Fat soluble = associate with fat to be absorbed & transported in blood
  - Water soluble (C, B complex) – dissolve easily in water
- Water soluble vitamins not stored
  - B vits need to be supplied regularly
  - B vits produced by microbial synthesis in LI
  - But – disruption to LI environment (e.g. ↑ starch diets) can affect this
  - Vit C synthesised in the liver

# Nutrient digestion

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Questions?

