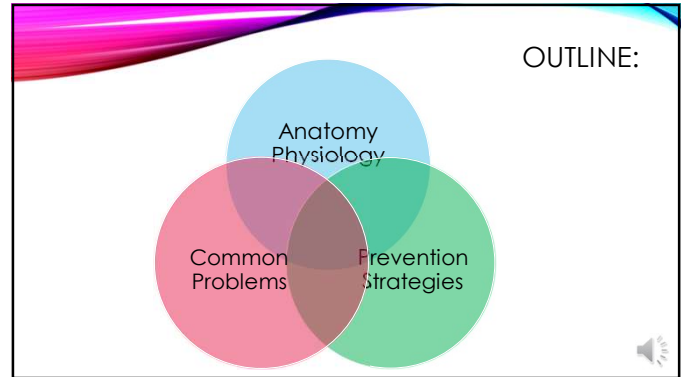
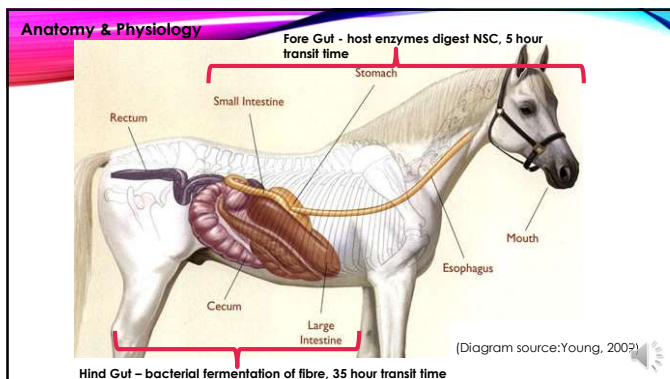




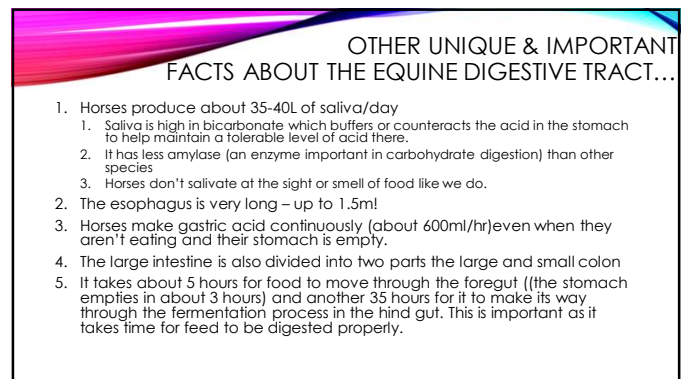
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4

CARBOHYDRATES (CHO) FORM THE BULK OF THE EQUINE DIET

There are several ways which CHO's can be classified into groups. For the purposes of this course we will use the terms structural and nonstructural.

Structural carbohydrates or **SCs** are also referred to as **fibre** and are an important part of the equine diet.

E.g. Pasture grass and hay.

Nonstructural carbohydrates or **NSCs** include mucilages, pectins, **sugars and starches** which are also important components of the equine diet. However, if the diet is too high in NSCs particularly sugars and starches, this can cause some issues with the digestive system which we will discuss after first discussing how the horse's digestive system handles SCs and NSCs.

E.g. sweet feeds, grains, stressed pastures, spring grasses and fall grass after freezing tend to also be high in NSCs

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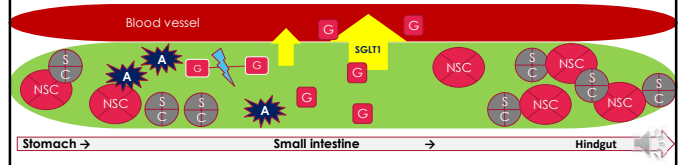
ENZYMATIC DIGESTION OF CARBOHYDRATES (CHO)

Rate limiting steps of NSC (non structural CHO) digestion/absorption:

1. Amylase production
2. Number of Sodium glucose transporter 1 (SGLT1)

Takes several weeks for adaptations to occur with increasing dietary NSC.

There is also a limit to the response and it likely varies between individuals. (Dyer et.al., 2009)



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PASSAGE RATES OF FEED THROUGH THE DIGESTIVE SYSTEM

Another rate limiting factor in digestion is the rate of passage of food through the digestive tract. The process of enzymatic digestion and bacterial fermentation take time. If food moves too quickly (as occurs if the diet does not contain enough fibre/forage) digestion is incomplete and can have detrimental effects.

Remember:
"Slow and steady" wins the race
 ... in digestion too!



From the time a horse takes a bite of food it should normally take about **40 hours** for it to be processed and the unusable parts to be passed out as manure.

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MICROBIOTA

- Normal variation in bacterial population between regions of the digestive tract and between individual horses (Ericsson et.al., 2016)
- Bacterial populations vary over time even in healthy horses living at pasture with minimal management (Salem et.al., 2018)

Issues arise when an extreme change in the digestive tract environment occurs resulting in an extreme change in the bacterial population.

E.g. stress, rapid changes in diet, medications

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MICROBIOTA

3 bacterial groups of interest:

- SC (fibre) fermenters: high pH environment > produce VFA horse can use
- NSC (especially sugar & starch) fermenters: low pH environment > produce lactic acid (in addition to VFAs)
- Lactate utilizing bacteria: low pH environment

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Some Common Problems:

(Diagram source: Young, 2007)

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CHOKES (ESOPHAGEAL OBSTRUCTION)

Factors contributing to the risk of choke occurring:

Esophagus is 1.2-1.5m long

35-40l saliva/day stimulated by chewing
Fibre size and saliva volume are directly linked to chewing time. (Merit and Julland, 2013)

Pelleted, cubed feeds, forage and large pieces of fruit/vegetables implicated.
Increased risk if horse dehydrated or eats fast.
(Duggan and Bentz, 2004; Sanchez, 2018)

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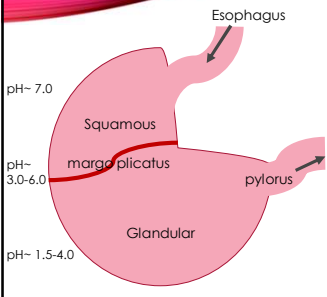
CHOKES

Prevention Tips:

1. Large rocks placed in feeders help slow ingestion
2. Increasing fibre and use of small hole hay nets increases chewing time (Ellis et.al., 2015)
3. Soak pelleted feed especially beet pulp
4. Cut apples, carrots and other treats small enough

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EQUINE GASTRIC ULCER SYNDROME (EGUS)



EGUS is divided into two separate conditions based on the location of the stomach affected:

- **ESGD** (Equine Squamous Gastric Disease)
- **EGGD** (Equine Glandular Gastric Disease)

Although the horse makes A LOT of saliva to neutralize acid in the stomach...the stomach continually produces acid (about **600ml/hr**) even when the horse isn't eating & the stomach is empty.

It becomes a contest between the two to maintain the pH in the stomach at a healthy level.

(Luthersson et al., 2009)

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GASTRIC ULCERS

Factors which increase acidity in the stomach increase the risk of ulcers	Reference:
Grass vs alfalfa hay	Lybber, Gibbs, and Cohen, 2007
Straw as sole dietary forage	Luthersson et al., 2009
> 6 hours between meals	
High starch >2g/Kg BW (Body weight)/day	
Water not freely available	

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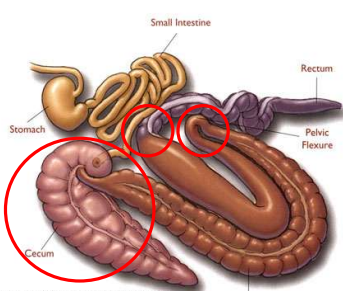
GASTRIC ULCERS

Prevention Tips:

1. Consider including alfalfa as a portion of the dietary forage
2. In general feed small frequent meals or provide forage adlib
3. If feeding concentrates, feed multiple smaller meals
4. Water freely available
5. Provide forage which is not excessively coarse and avoid only providing straw
6. Don't ride your horse on an empty stomach – acid splashes up onto the more sensitive squamous part of the stomach.

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IMPACTION COLIC



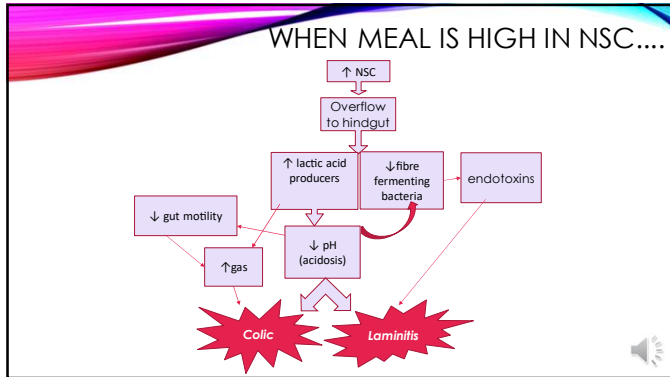
Associated risk factors:

- Dehydration
- Coarse feed
- Sudden decrease in exercise
- Feeding meals high in Non structural carbohydrates (NSC)

(Hallowell, 2017; Sanchez, 2018)

(Diagram source: Young, 2009)

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CALCULATING NSC CONTENT IN A MEAL FOR YOUR HORSE

The amount of NSCs your horse gets in his diet has important implications for his digestive health. Knowing how to calculate how much you are feeding is helpful.

Let's compare two commercially available feeds...

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STEP 2 "SWEET FEED"	VS	STEP 3 "FORAGE REPLACER"
<p>Feed Analysis (CANADA) Crude Protein (min) 14.0% Zinc 316 mg/kg NSC 31.3% Crude Fat (min) 10.0% Cobalt 0.32 mg/kg Crude Fibre (max) 12% Selenium (added) 0.43 mg/kg Sodium 0.5% Vitamin A (min) 14,000 IU/kg Vitamin D (min) 2,240 IU/kg Phosphorus 0.8% Vitamin E (min) 625 IU/kg Magnesium 0.32% Thiamin 16.1 mg/kg Riboflavin 10.2 mg/kg Copper 52 mg/kg Pyridoxine 14.1 mg/kg Manganese 208 mg/kg</p>		<p>Feed Analysis (CANADA) Crude Protein (min) 15.0% Zinc 282 mg/kg NSC 8.8% Crude Fat (min) 3.0% Cobalt 0.3 mg/kg Crude Fibre (max) 21.0% Selenium (added) 0.3 mg/kg Sodium 0.4% Vitamin A (min) 9,000 IU/kg Calcium 1.5% Vitamin D (min) 1,500 IU/kg Phosphorus 0.5% Vitamin E (min) 80 IU/kg Magnesium 0.23 Thiamin 13.0 mg/kg Riboflavin 13.0 mg/kg Copper 46 mg/kg Manganese 196 mg/kg Pyridoxine 26.6 mg/kg</p>

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CALCULATING NSC PER MEAL FOR A 500KG HORSE

Recommendation: no more than 1g/Kg BW/meal NSCs = **500g NSC/meal** for 500kg horse

Step 2 = 31.3% NSC = 313g / 1kg
 Therefore $\frac{\text{meal}}{500\text{gNSC}} = \frac{1\text{kg feed}}{313\text{g NSC}} \rightarrow$ **1.6kg feed/meal**

Step 3 = 8.8% NSC = 88g / 1kg
 Therefore $\frac{\text{meal}}{500\text{gNSC}} = \frac{1\text{kg feed}}{88\text{g NSC}} \rightarrow$ **5.7kg feed/meal**

That means this horse could have about **3.5 times as much Step 3 in one meal than Step 2 & still be within the recommended limit of NSCs per meal.**

He might prefer the sweet feed, but his digestive tract will be better off: he will spend more time chewing & making saliva to buffer gastric acid and have a fuller belly for longer ☺ AND he will be entertained for longer!

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☀ PREVENTION TIPS:

1. Forage should make up the bulk of the diet at a rate of 1.5% BW DM minimum.
2. Keep dietary NSCs low - no more than **1g/Kg BW/meal** (Hoffman, 2013)
3. Increasing dietary fibre and use of small hole hay nets increases chewing time= ↑ saliva to neutralize acid (Ellis et.al., 2015)
4. Feed small frequent meals with no more than 6 hours between feeding or ad lib.
5. Consider adding some alfalfa.
6. Water freely available.
7. Make dietary changes slowly over several weeks to allow adaptations to occur.

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CONCLUSION:

Is the Equine Digestive Tract Designed for problems?

Although the equine digestive tract can experience a multitude of problems they are not entirely due to design flaws but due to feeding management choices which conflict with how the system was designed to function optimally.

Implementing the tips provided can help the system run quite smoothly!



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