Some important anatomical and physiological characteristics

Origin of the domestic rabbit (*Oryctolagus cuniculus*)

- Originated in Iberian peninsula – hot, dry and arid for some of year
- Rabbits can exist in these conditions

Warrens

Social groups

- Like to live in social groups of 6-8 within warrens
- Aggressive to rabbits outside group
- Pet rabbits also like to live in groups
- Must be neutered
- Male and female is usual combination
- Mutual grooming is one of many benefits

Reproduction

- Gestation lasts 30-32 day
- Litter size 4-10
- Female can be mated again as soon as she has given birth

Choice of nesting site

- Nesting site is important for survival of young
- Dominant females choose best places
- Defend the site
- Nest is dug out and defended in preparation
- Carefully hidden and blocked between visits

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**Preparation for parturition**

- Female pulls hair from her ventral abdomen to line nest
- Although she leaves nest, she will stay close and attack intruders or run to divert them
- Maternal aggression is also seen in pet rabbits, especially if not neutered

**Parturition**

- Usually takes place in morning
- Over in 30 minutes
- Dystocia is rare

**Baby rabbits**

- Rabbit babies born blind and without fur
- Leverets born with fur and ready to run. Not born in a nest

**Maternal behaviour**

- Minimal maternal behaviour
- Babies suckled for 3-5 minutes once daily
- Very concentrated milk
- Babies emerge from nest after about 3 weeks
- Abandoned and left to own devices at about 4 weeks when mother about to give birth again

**Nest disturbance and maternal mutilation**

- Mother may attack and eat babies if they are disturbed
- May chew off ears or limbs

**Natural diet**

- Rabbits are strict herbivores
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Seasonal variation in diet

- Seasonal variation in availability
- New growth, fruit and seeds at different times of year
- Will strip bark in winter
- GI tract can cope with all these different foods

Herbivorous diet

Plants consist of:
- Roots
- Leaves
- Stems
- Flowers
- Seeds
- Fruit
Rabbits eat all parts of the plant

Composition of plants

- Plant cells contain carbohydrates, sugars and other nutrients as a result of photosynthesis
- Herbivores, such as rabbits, have teeth that cut or crush plants to release cell contents

Nutrients in plants

- Fibre
- Starches
- Sugars
- Proteins
- Oils
- Vitamins
- Minerals

Digestion

Definition of dietary fibre?

- Food that reaches the colon (large intestine) undigested by enzymes
- Composed of strands of plant cell walls
- Plus other substances that are not broken down by digestive enzymes-oligosaccharides (prebiotics), inulin etc.
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**Composition of dietary fibre**
- Pectic compounds (water soluble polysaccharides)
- Cellulose
- Hemicellulose
- Lignin - that may be bound to cellulose and hemicellulose

**Digestion of fibre**
- Fibre is not broken down by digestive enzymes
- Some of it can be broken down by micro-organisms
- Herbivorous species have a digestive system that utilises microbial breakdown of fibre

**Digestion in rabbits**
- No rumen
- Micro-organisms are in caecum
- ‘Hindgut fermenters’

**Ingestion of food**
- Need to watch for predators as they eat
- Don’t look at their food

**Appearance of food**
- Not important to rabbit
- Muesli mixes are made to look good to owners

**Dentition**
- Sharp teeth to cut through fibrous food
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Cheek teeth

Cheek teeth act as a series of scissor-like blades.

Stomach

- Always contains food
- Usually contains caecotrophs
- Strong cardiac sphincter so rabbits cannot vomit or burp
- Distensible

Digestion in stomach and small intestine

- Same as in other species
- Protein broken down to amino acids that are absorbed
- Lipids are absorbed
- Starches are broken down to sugars
- Sugars are absorbed

Sacculus rotundus

- Small intestine ends in dilation called sacculus rotundus
- Can be located by reflecting colon
- Contains lymphoid tissue
- Opens into T-junction with caecum one way and colon the other

Composition of food that reaches the hindgut

- Fluid
- Desquamated cells
- Mucus
- Fur
- Fibre

Function of the colon

- Probably most important part of rabbit’s digestive system
- Adapted to mix and separate contents into two parts
  1. Small particles and fluid
  2. Large particles
- Simultaneously sends them in opposite directions
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**Importance of particle size**
- **Small particles** (<0.3mm) are mostly composed of pectic substances and cellulose with some lignocellulose
- Can be broken down and converted into nutrients by micro-organisms
- **Large particles** are composed of lignified material that can’t be broken down easily
- Large particles have little or no nutritive value

**Features of colon**
- First (proximal) part of colon is anatomically distinct from last (distal) section
- Proximal section has:
  1. *Taenia* - longitudinal muscular 'ribbons'
  2. *Haustra* - sacculations that 'pump' contents along
- Distal section is smooth tube

**Separation of ingesta**
- Small particles and fluid accumulate in haustra and are moved into the caecum
- Large particles accumulate in lumen of gut and are moved along colon by action of taeniae

**Fusus coli**
- 3-4cm section of colon
- Feature of lagomorphs
- Pacemaker for hindgut motility
- Innervated and vascular
- Affected by metabolites, hormones and autonomic nervous system
- Compresses ingesta into pellets as water is drawn out

**Pellet formation**
- *Fusus coli* has thick muscular wall
- Compresses the contents into pellets
- Absorbs water from contents as they pass through

**Passage of hard faeces**
- Occurs for most of day, when rabbit has eaten and filled stomach and intestine with food
- Large numbers of hard faecal pellets are passed
- Size and consistency depends on amount of lignified material in diet
- Contain pieces of plant material and fur- little else
### Meanwhile - in the caecum

- Caecum is full of microbes
- Nourished by nutrients and fluid entering it
- Buffered (maintaining correct acidity) by bicarbonate
- Contents are gently mixed by contractions
- Water and nutrients can be absorbed from caecum across the wall

The appearance of these guts is not normal - it was an ill rabbit

### Hindgut fermentation

- Hindgut means the caecum and colon
- Rabbits are 'hindgut fermenters' like horses
- Caecum is filled with microbes that can break down fibre
- Colon is adapted to separate contents into large and small particles and send them in opposite directions

### Caecal microflora

- Huge range of organisms - aerobic and anaerobic bacteria, protozoa, yeasts
- Not all have been identified
- Balance is affected by substrate, pH, time of day

- Bacteroides
- Clostridia
- Archaea (methanogenic)
- Cyniclomyces guttulatus

### Fattening fibre

- Small particles of fibre tend to composed of pectic substances and cellulose
- Can be broken down and converted to nutrients in caecum
- Nutrients can be converted into fat
- Anything that can be puréed is fattening for rabbits

### Caecal contraction - soft faeces phase

- Once (or twice) daily the gut motility alters
- Colon stops mixing and separating ingesta
- Caecum contracts to expel most of its contents into colon
- Expelled as ‘caecotrophs’

### Caecotrophs

- Mucus encapsulated
- Full of bacteria and other micro-organisms
- Smell strongly because of VFA content
- Smooth pasty consistency - look like diarrhoea
- Source of nutrients that are constantly available
- 'Packed lunch' rather than faeces
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**Ingestion of caecotrophs**

- Occurs during periods of rest
- Usually morning in pet rabbits
- Ingestion of caecotrophs is stimulated by hunger, smell and sensation
- Caecum is big so large amounts of caecotrophs are passed and ingested

**Digestion of caecotrophs**

- Caecotrophs remain in fundus protected by mucus
- Microbial digestion continues to produce lactates and glucose
- Eventually digested and nutrients absorbed from stomach and small intestine

**Advantages of caecotrophy**

- Efficient form of digestion of plant material
- Digests parts that can be broken down in stomach and small intestine
- Eliminates part with no nutritive value rapidly
- Converts remainder into nutrients that are eaten and digested

**Disadvantages**

- Relies on optimal gut motility to drive food through digestive tract
- Digesta needs to be separated into small and large particles effectively
- Gas producing organisms in all parts of GI tract
- Things can go wrong

**Gut Stasis**

- Very common in pet rabbits
- Slow gut motility die to adrenergic stimulation
- Cause (or effect) of anorexia
- Secondary problem
- Primary cause may be minor or serious
- Easy to prevent and treat
- Potentially fatal if not recognised and treated

**Start of gut stasis**

Triggering factors:
- **Pain** - from surgery, abdominal catastrophe, wounds etc. etc.
- **Stress** - travelling, loss of a companion, change in environment, dominant companion, pain

A trip to the vets can involve several triggering factors for gut stasis
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Demeanour of rabbit

Still bright and responsive at outset

Initial changes in GI tract

• Empty feeling gut
• Small stomach
• Food doesn’t move through gut
• Pockets of gas collect in intestines
• Faecal output ceases
• Hard faeces may accumulate in colon

Normal radiographic appearance of abdomen

Left
Right

After 12-24 hours

• Smaller stomach
• Empty ileocaecocolic complex
• Reduced absorption of glucose from gut
• Reduced absorption of nutrients to and from caecum
• Blood glucose falls

Digital radiography

Initial changes in GI tract

• Empty feeling gut
• Small stomach
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Further progression
- Dehydration
- Stomach contents become dry and impacted
- More gas accumulates in gut – painful

Demeanour of rabbit
- Often sitting quietly at back of cage
- Hunched posture
- No interest in eating on its own
- Will probably take syringe feed (why?)

After 24-48 hours
- Gas continues to accumulate in stomach and caecum
- Stomach contents become more impacted - may be palpable as a hard mass in stomach

Hairball
- Gastric contents become dry
- Always contain lots of fur from grooming
- End up with large ball of impacted fur
- ‘Hairball’
  - Effect not a cause of the problem

Demeanour of rabbit
- Often sitting quietly at back of cage
- Hunched posture
- No interest in food
- May frantically chew paper or hay
- ? Response to abdominal pain.
  - Need urgent treatment

Glucose will be low, normal or slightly raised

Gastric ulceration
- Can occur in rabbits with gut stasis
- Only diagnosed during post-mortem examination or laparotomy
- Role of NSAIDs is uncertain

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**Meloxicam**
- Trend to use high doses (0.6-1.5mg/kg)
- Based on a study of a small number of healthy (not ill) rabbits
- Showed that meloxicam is metabolised rapidly and rabbits are tolerant of high dose

*My opinion*
- Lower doses (0.15mg/kg twice daily) are effective and safer
- Is the option to use higher doses if needed

**Next stage: Hepatic lipidosis**
- After 4-7 days of untreated gut stasis
- Fat is mobilised and transported to liver as an energy source
- Metabolic bottle neck occurs
- Fat destroys liver cells
- Rabbit dies from liver failure

**Clinical features of hepatic lipidosis**
- Rabbits are cold and wobbly
- Unresponsive
- Pale mucous membranes
- Won't take syringe feed - dribbles out of mouth
- Terminal

**Prevention and treatment of gut stasis**
- Recognise any rabbit that is not eating and defaecating
- Identify and treat the underlying condition
- Provide effective analgesia
- Provide fluids
- Prevent negative energy balance by ensuring rabbit has food going through gut
- Stimulate gut motility
- Reduce stress

**Intestinal obstruction**
- Very common in rabbits
- Usually pellet of matted hair
- Usually passes through
- Can obstruct small intestine
- Sudden onset – ‘rabbit was fine yesterday’
- Can recover if obstruction passes through
- Or can die within hours if it doesn’t

**Gastric dilation with gastric tympany**
- Common emergency
- Sudden complete anorexia
- Palpably enlarged stomach
- NOT gut stasis
- NOT dietary
- Is due to physical obstruction in intestine

**Stage when some owners first notice a problem**

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**Recap:**
- Stomach is very distensible
- Strong cardiac sphincter—one way valve
- Rabbits cannot vomit or burp
- Saliva is continuously produced and swallowed
- Contents contains gas producing bacteria

**What happens if intestine is obstructed**
- No exit for food
- Rapid fermentation of stomach contents and gas production
- Fluid continues to be swallowed and secreted
- No exit for gas and fluid
- Stomach becomes distended

**Gastric dilation**
- Stomach is distended beyond normal limits
- Palpable behind ribs on left
- Rabbit is unwell
- Intestine fills with gas proximal to site of obstruction

**Demeanour of rabbit**
- Quiet
- Hiding
- Unresponsive
- May show signs of abdominal pain
- Increased heart rate (normal 150-250 bpm)

**Common cause of obstruction**
- Pellet of impacted fur
- Only found during surgery or post-mortem examination
- Can pass through so no definitive diagnosis made

**‘Hairy poos’**
- Large amounts of hair is ingested during grooming
- Compressed during passage through colon
- Passed out as pellets of compressed hair
- Some rabbits eat hard faecal pellets as well as caecotrophs

Blood glucose rises >15mmol/l
Blood glucose rises (>20mmol/l)
Blood glucose rises (>20mmol/l)
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What happens if rabbit swallows a hairy poo

- If it is small, the pellet will pass straight through
- If it is medium sized it can pass through but may obstruct intermittently
- If it is large, it will obstruct the small intestine completely

Pain may influence process by slowing gut motility

Moving pellets

- Pellet (or other foreign body) move along and periodically obstruct gut
- Analgesia will help
- Prokinetics might help
- Stomach massage, syringe feeding and forcing rabbit to run around are probably bad ideas

When pellet moves through ileocolic valve...

- All the gas and fluid that has built up in stomach and small intestine is released into hindgut
- Pellet passes through colon and out through anus

Radiographic changes

1. Gas in caecum is a good prognostic sign

What happens when obstruction goes through?

1. Pain resolves and rabbit feels better. Improvement in demeanour and return of appetite - may be interpreted as successful response to treatment

2. Or rabbit has been ill so long that shock, secondary paralytic ileus, acute renal failure and/or electrolyte imbalances kill it

Case report
Some important anatomical and physiological characteristics

Outcome

What if the obstruction does not pass through to hind gut?

Rupture of stomach or intestine

What do you do with a rabbit with gastric dilation

Whatever the decision, decompression is a good idea

Inconclusive results?

Some important anatomical and physiological characteristics

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Inconclusive results?
Some important anatomical and physiological characteristics

Inconclusive results?
- Hospitalise
- Offer tempting foods
- Give analgesia
- Observe
- Examine again in an hour or so
- ? Take another radiograph
- ? Take another blood sample

Surgery for intestinal obstruction

Locate of obstruction
- Easy, intestines are
- Look at radiographs
- Look for loop of distended intestine
- Follow it along to obstruction

Or milk it along intestine

Important to keep gut moist

Pushing pellet through ileocolic valve

Post-operative care
- Analgesia
- Antibiotic
- Prokinetics - metoclopramide and domperidone because paralytic ileus is a risk
- Ranitidene
- Tempting food - grass/dandelions
- ? Syringe feed - probably not immediately
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Success rate

- Greater than 50% - probably 60-70%
- Better if performed early
- Some rabbits have multiple surgeries
- Ninja (my rabbit) was operated on twice. (PTS third time)
- Another in practice - three times

The end