



Gut health in poultry

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Gut anatomy, development and function

Gut overview

- Gut health is essential for good growth and FCR
- Gut health relies on acquisition and maintenance of a balanced gut flora
- Gut health relies on the proper development of the gut tissues
- Intestinal tract is the largest organ in the body
- Contains ~70% of a bird's immune cells
- Intestinal tract is a larger in terms of % of overall body weight early in life

Gut overview

- A specialised tube running the from beak to the cloaca where feed is digested and absorbed
- Divided into distinct regions
- Each region has a specific role
- Each region has a specific structure

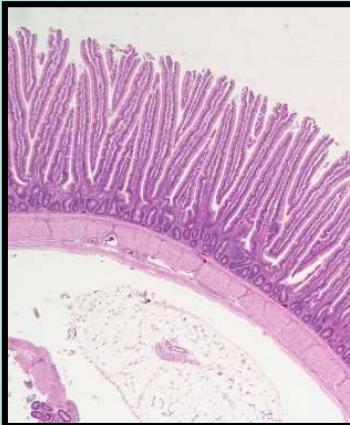
Gut anatomy and ap

Small intestine:

Feed is mixed with bile, bicarbonate and enzymes to start digesting the lipids, proteins, sugars in the diet.

The resultant molecules are then absorbed through the transport around the body

The villi and microvilli intestine provide a large for this to occur



Caeca:
Outpouching of the oesophagus
Feed is softened and fermented
Held for up to 6 hours
PH of around 5.5
Indicates start of digestion

Large intestine

The caeca is the site of major bacterial fermentation.

Caecal contents consist of the material the bird is unable to digest or which has not been absorbed.

From this the bacteria produce shortchain fatty acids, organic acids, vitamins and other nutrients that can be absorbed by the host

The colon is a short region where some water absorption occurs

Proventriculus:

- Proventriculus secretes acid and pepsin
- Feed stays in this region for short time
- pH 2.5-3.5



Gizzard:

- Mechanically grinds the feed
- Tough inner koilin layer
- Thick outer muscular layer
- Sets the rate of feed passage



Cornell University

The result of good digestion!



Caecal dropping



Faecal dropping

Very important to recognise the difference in these types of droppings

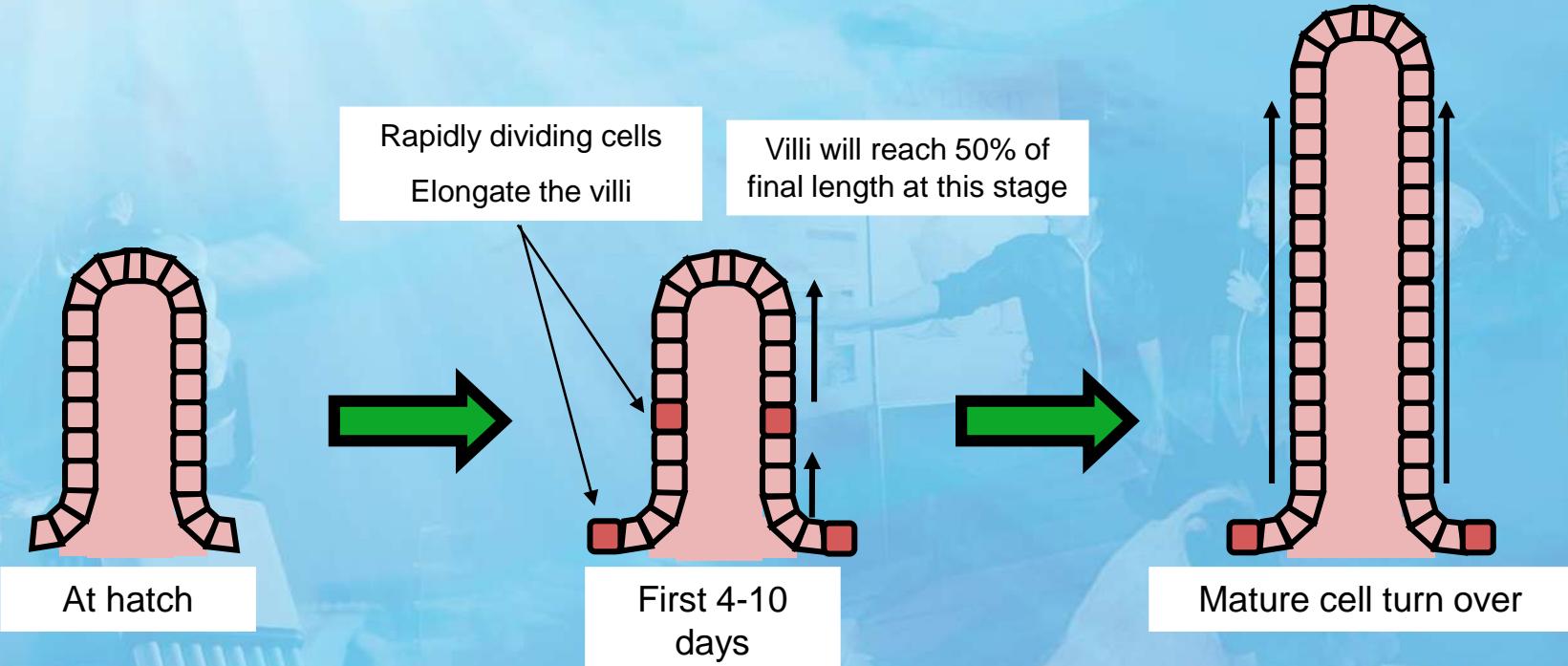
- Consequence of impaired digestion
 - Feed passage
 - Fatty and wet faeces
 - Poor FCR



Gut development

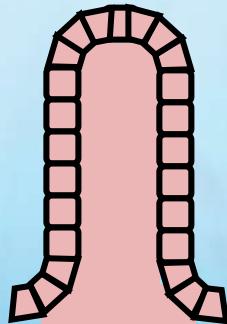
- Day 17 of incubation till hatch – key period
 - An indicator of poor in-egg development is poor gut tone
- After hatch the gut starts to mature
 - Switch from yolk nutrition to external feed
 - Enzyme production increases
 - Immune system starts to mature
 - Gut flora starts to colonise
- First 10 days when villi undergoing rapid development
 - Maximum development at 4 days in duodenum and 10 days in jejunum and ileum
- If the birds are stressed likely to impair gut maturation

- Villi development

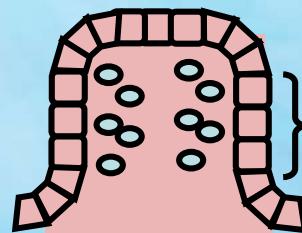


- Factors such as cold stress and poor feed/water access can impair this development.
- A key aspect of villi development is stimulation from the gut microbiota

- Impact of poor development

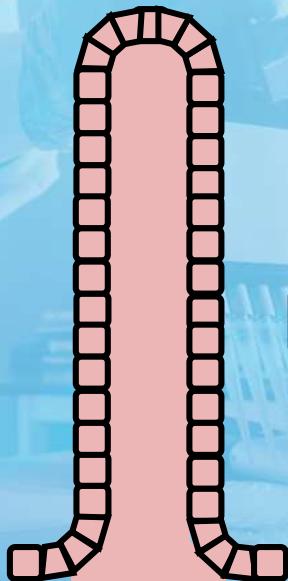


Poorly developed

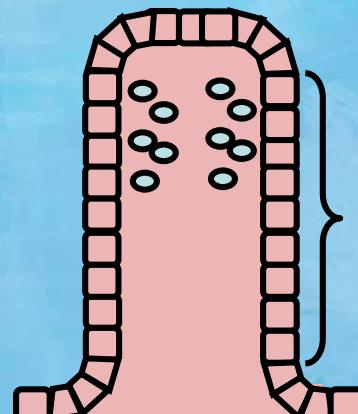


Cocci infection
Villi become fatter and shorter

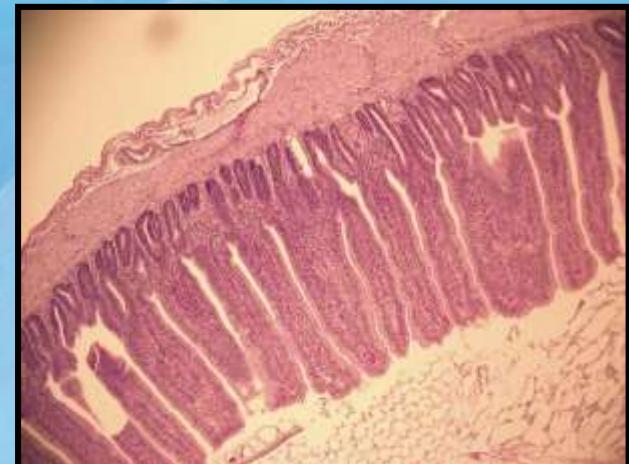
Ability to absorb nutrients is reduced



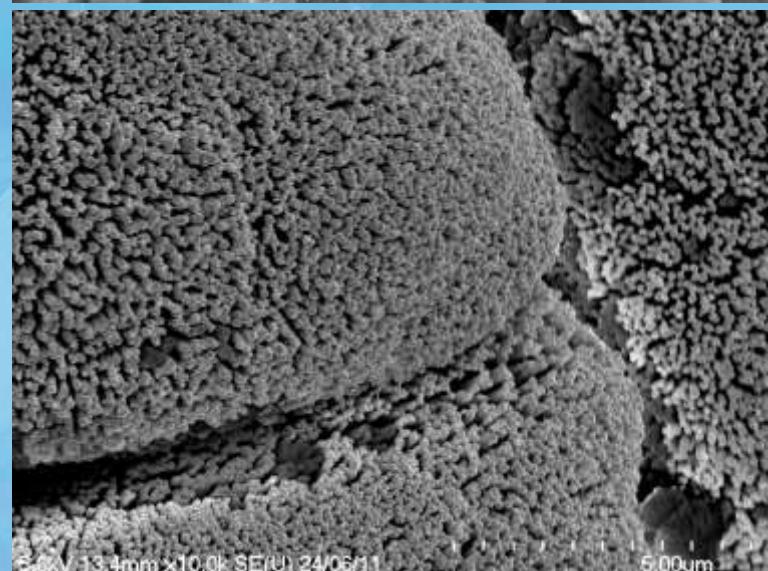
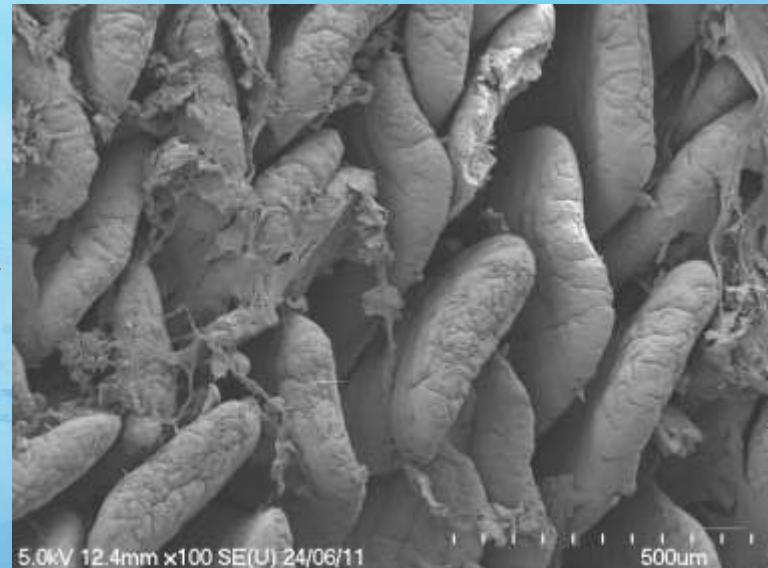
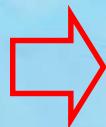
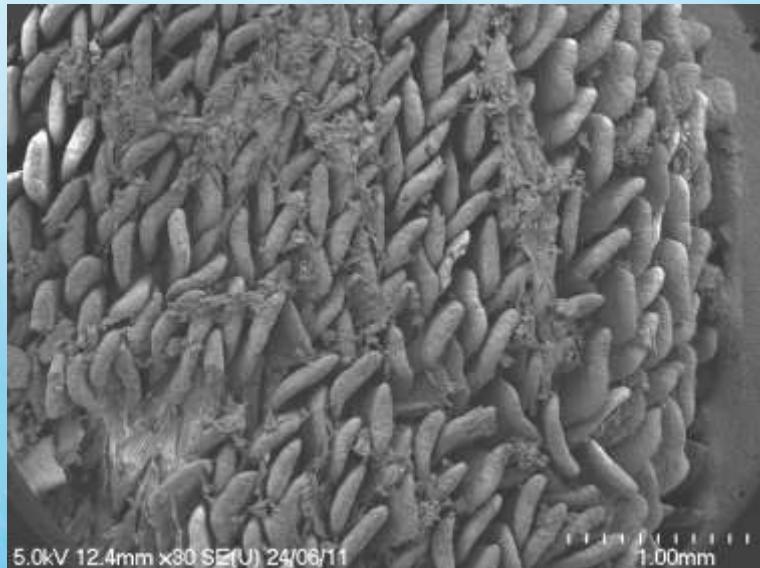
Well developed



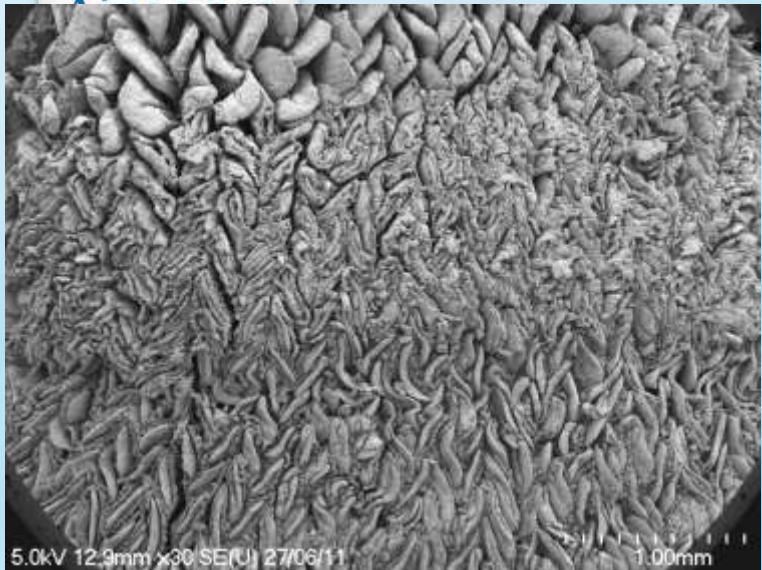
Less impact on ability to absorb nutrients



Scanning electron micrographs

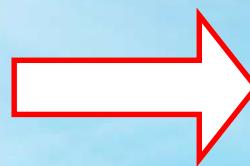


- They are long and free with intact villi tips
- Microvilli are even and regular



5.0kV 12.9mm x30 SE(U) 27/06/11

1.00mm



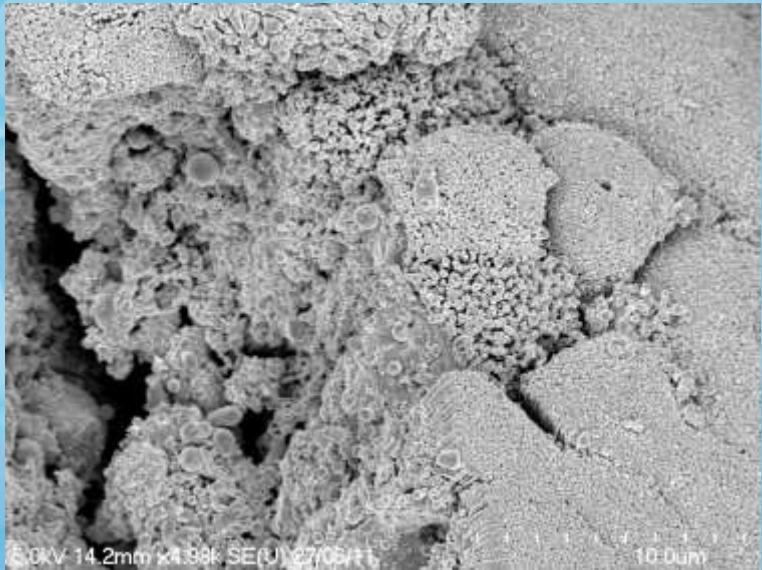
layers of
enterocytes
appear to be
peeling away
from the villi
core



5.0kV 12.9mm x100 SE(U) 27/06/11

500um

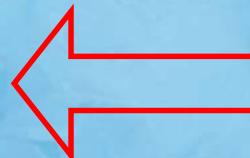
Poor villi. There is severe erosion of the villi tips



5.0kV 14.2mm x4.99k SE(U) 27/06/11

10.00μm

The microvilli
appear
stunted and
irregular



5.0kV 14.2mm x1.01k SE(U) 27/06/11

50.00μm

Monitoring gut health

Indicators of poor gut health

- A gut health problem usually manifests itself with
 - Poor growth rates
 - Flock uniformity
 - Wet litter
 - Wet faeces
 - Feed passage
 - Frothy caecal droppings

Gut Scoring

- Giving a gross overview of gut function
 - Ongoing infections or disruptions of gut function
 - Efficiency of absorption of nutrients
- In younger birds (e.g. 7 days)
 - Can indicate quality of brooding
- Can give an indication of underlying gut issues
 - Malabsorption
 - Poor uniformity
 - Feed quality
- Also allows a flock to flock measure of gut health

Gut Scoring

- Birds scored:

- Redness of the mucosa

Scored scale:

Bird ID: Bird Breed:		Gizzard Erosion			Coccidiosis			Feed passage		
		0	1	2				Yes	No	
	Redness			Gut tone			Consistency of contents			Mucus
	Duodenum	0	1	2	0	1	2	0	1	2
Jejunum	0	1	2	0	1	2	0	1	2	Yes No
Ileum	0	1	2	0	1	2	0	1	2	Yes No
Caeca	Colour: Dark Light			Consistency: Watery Pasty			Foamy		Gassy	
<u>Other notes:</u>										



Gut scoring

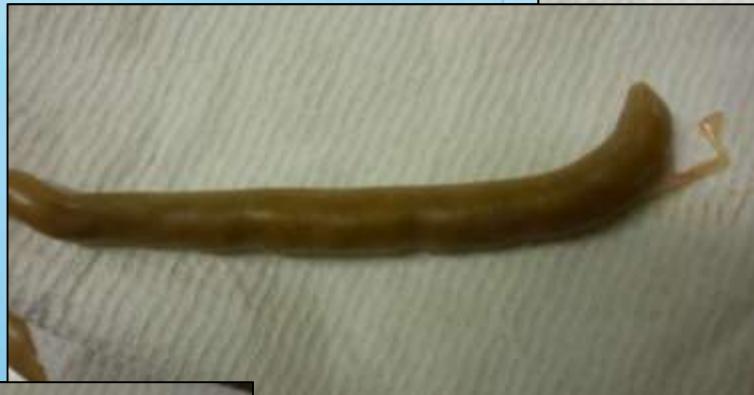
- Is there mucus present?
 - In the duodenum mucus is common
 - In jejunum and ileum you shouldn't see mucus
- Is there feed passage?
- What do the caeca look like?
 - Presence of gas
 - Consistency
 - Colour

Caecal characterisation

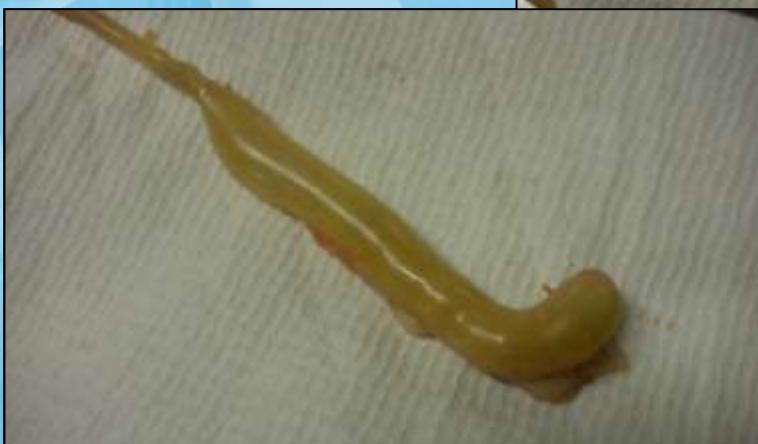
Normal



Mild imbalance



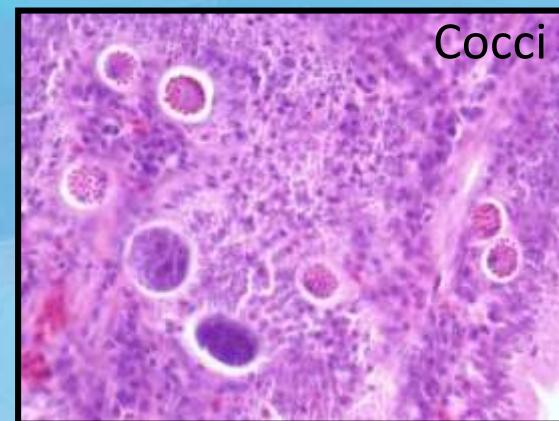
Severe imbalance



Gut histology

- Histology can help us explain changes we see in gut morphology
- Highlight sub-clinical disease
 - Coccidiosis
 - Viruses
- Show appropriate development
 - Highlighting previous challenges (management and disease)

Gut histology



Cocci in the gut

- It is sometimes possible to see the effects of subclinical coccidiosis at the gut surface



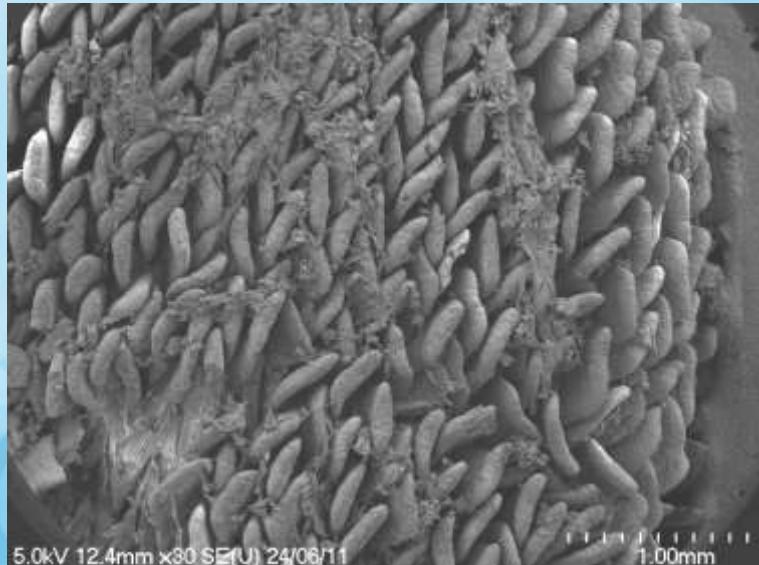
Normal even layer of villi



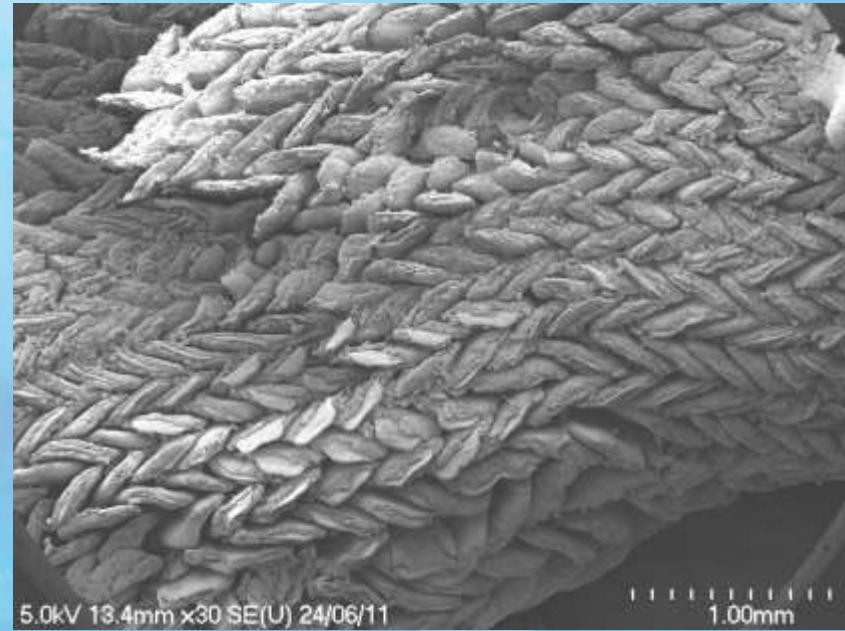
During cocci infection the villi become shorter and fatter resulting in a distinctive pattern

Cocci in the gut

- Electronmicroscopy can show this nicely



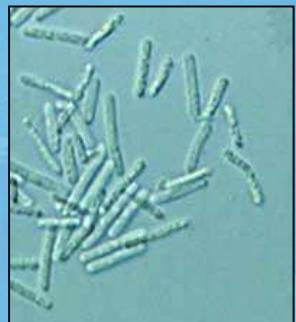
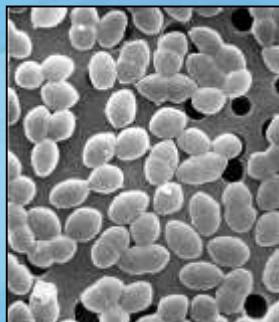
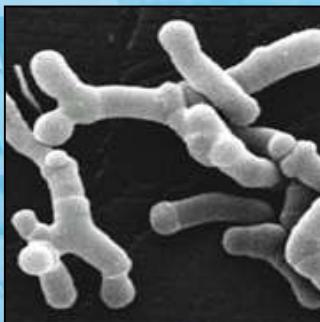
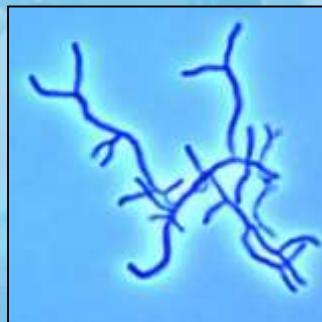
Normal villi



Cocci infected villi. This is the pattern you can see

Gut Microbiota

- Gut Microbiota
 - Community of bacteria, viruses, fungi and protozoa living in the gut
 - Approximately 700-800 species of bacteria in the chicken gut
 - Bacterial cells outnumber host cells 10:1
 - Consumes ~20% of dietary energy
 - Highly metabolic organ



- Helps to direct the development of gut structure and gut immunity
 - Different bacteria influence the gut in different ways
- Modulates the immune response
- Aids digestion
- Produces nutrients from non-digestible dietary components
- Offers protection from gut pathogens

- The microbiota of a chicken takes a few weeks to fully mature
 - Crop colonised within 24 hours
 - One day post-hatch the ileum and caeca are both dominated by bacteria
 - After three days these levels increased 10-fold
 - Within two weeks the adult small intestinal microbiota will be established
 - After 30 days the caecal flora will have stabilised
- During this time the microbiota can be disturbed leading to dysbacteriosis and/or wet litter.
- Essential to ensure the gut gets a good start to ensure quicker maturation of microbiota

Which bacteria are present?

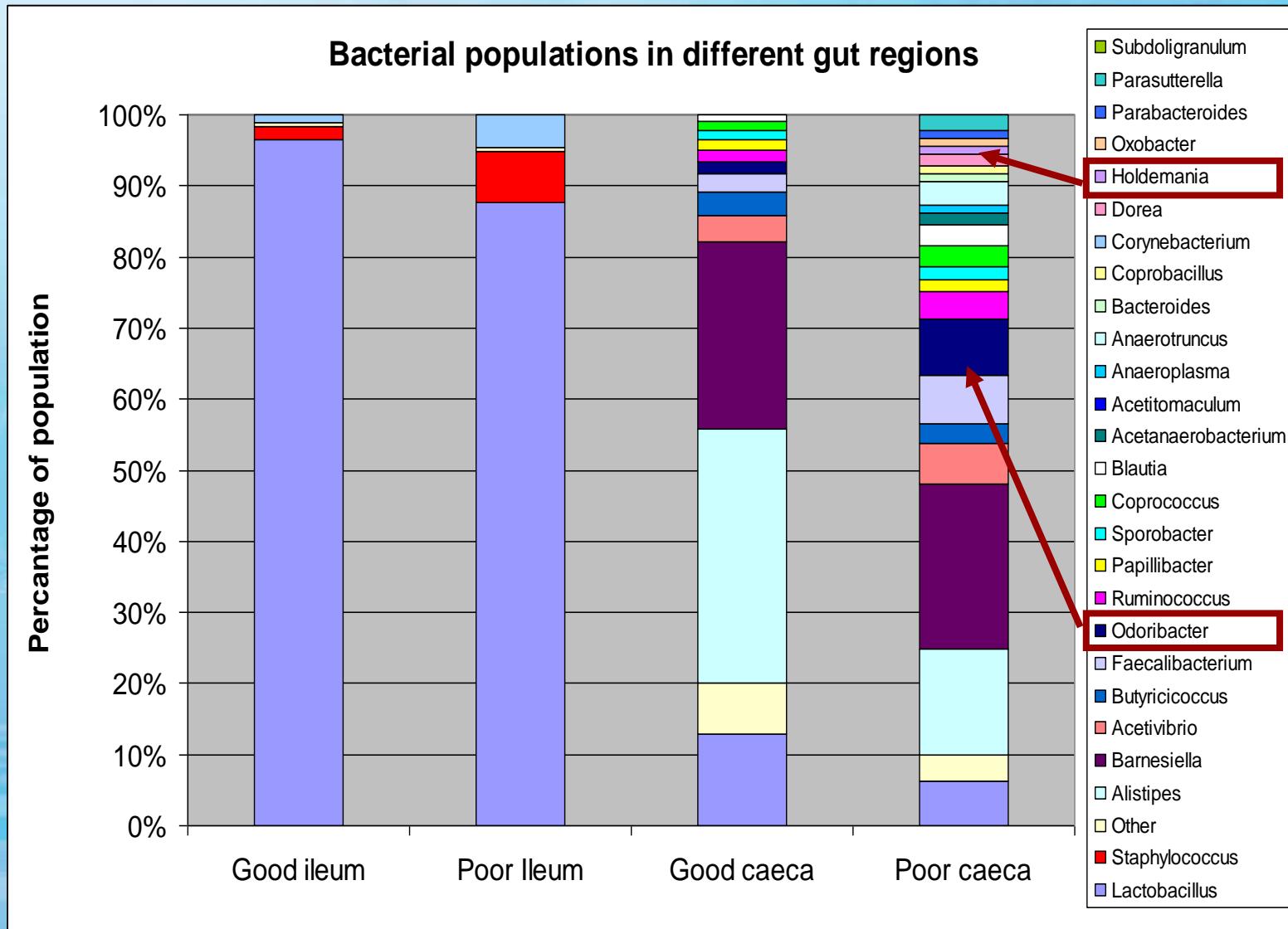
- Small intestine
 - Dominated by lactic acid producing bacteria (Lactobacillus and enterococcus)
 - These dominate the gut throughout the life of the bird but the species differ as the birds age
- Large intestine
 - Early in life lactic acid producers and bacteroides
 - Later in life fermentative clostridia and bacteroides

Under normal circumstances the flora contains favourable
and less favourable bacterial species

Development of the microbiota

- Where do the pioneering bacterial species come from?
 - Hatchery environment
 - Hatchery staff
 - Farm environment
 - Feed
- On the farm chicks will be exposed to the remaining flora from the previous flock
 - Impact on chicks
 - Wet vs dry cleaning

Intestinal microbiota fluctuations



Microflora during upset

- Shifts in microbiota are indicative of malabsorption
 - Poor fat absorption
 - Sugar, fat and protein available in the caeca
- More nutrients for bacteria
- Bacterial overgrowth
 - CO_2 , CH_4 , H_2S produced
 - Toxic amines (irritates gut and causes growth depression)
 - Bile acid inactivation (impairs fat absorption)
- Leads to further digestive upset

- Gut health and microbial community affected by
 - Feed substrate – Cereal, protein and fat type
 - Feed form – mash/crumb/pellet
 - pH
 - Viscosity and water content
 - Nutrient density
 - Overall bird health – stress, immuno-suppression etc.
 - Early gut development

Gut microbiota and gut health

- It is easy to simply focus on which bacteria are in the guts
 - Gut health is based on the dynamic between many factors
 - Gut microbiota will fluctuate naturally
 - Often the microbiota seen in a gut upset is a secondary affect
 - In the absence of a properly developed gut the bacterial population will never be stable



A collage of images illustrating various aspects of avian health and agriculture. It includes a surgeon performing a procedure, a scientist working at a computer, a group of people in a meeting, a person in a white coat, and several birds.

Influencing gut health

- On the farm gut health can be influenced from day 1
 - Key aspect is to get feed into the chick to feed the gut
 - Correct brooding temperatures
 - Too hot the chicks don't want to eat
 - Too cold and the chicks huddle and don't eat
 - Good access to feed and water
- By doing this the gut development is optimal
- Ensure the birds are equipped to cope with gut challenge

Products to improve gut health

- Direct fed microbials
 - Probiotics
 - Defined bacterial products (<10 strains)
 - Lactic acid producers
 - Lactobacillus, enterococcus, pediococcus etc.
 - Bacillus products
 - Microbiota modulators
 - Fed in feed or added direct to litter
 - Competitive exclusion agents
 - Undefined bacterial products
 - Aviguard
 - Broilact

Products to improve gut health

- Organic acids
 - Often only active in the foregut (Crop, gizzard, duodenum)
 - Lower pH
 - Provide nutrients for other bacteria (Lactic acid)
 - Antibacterial (Acetic, formic, benzoic)
 - Stimulate gut tissues (Butyric, propionic)
- Phytobiotics
 - Essential oils (Oregano, thyme, clove, cinnamon)
 - Antibacterial
 - Gut stimulatory

Interestingly organic acids and essential oils seem to work better together

Products to improve gut health

- Oligosaccharides
 - Fructo-oligosaccharides (FOS) – Prebiotics
 - Provide a dedicated nutrient source for fermentative bacteria
 - Chicory root , fruit pectin
 - Often included in probiotic mixes
 - Mannan-oligosaccharides (MOS)
 - Yeast cell wall
 - Block attachment of *E. coli*, *Salmonella spp.* to the gut wall
 - Lactulose
 - Sugar substitute
 - Fermented by bacteria
 - Often in probiotic mixes

Reason for using these products

- Improve gut integrity
- Stimulate or provide a beneficial flora
- Improve gut function
- Inhibit pathogens
- Reduce antibiotic usage
- Alternative to Antibiotics?
 - Preventative rather than therapeutic
 - One product to fit all situations?

- ***Do they work?***

- They work with the right product given at the right time in a bird's life in the right manner.
 - Early in life
 - 3-5 days over a stressful event
 - Feed vs water
- All experimental data will show they work
- Have to remember there is no one product that will help in all situations
- Choose a product that is suited to your management strategy and the problem you see

Examples of improper use

Giving a probiotic if:

- You regularly use antibiotic growth promoters
- If your water supply is heavily chlorinated (>5ppm)

Why? These are likely to kill off any probiotic

Solution: Use a product to stimulate the gut such as a prebiotic or organic acid.

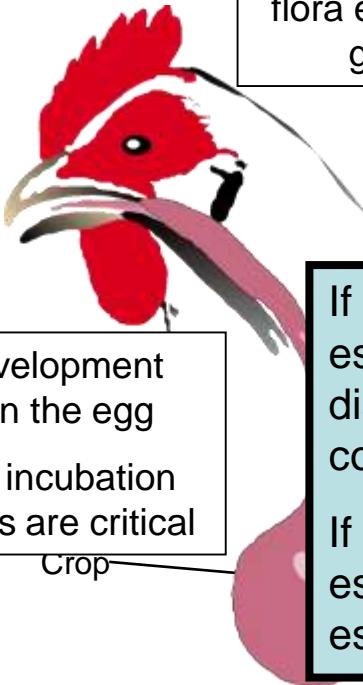
Giving a probiotic at the hatchery with antibiotics

Why? Probiotic bacteria will be killed by the antibiotic

Solution: Use a probiotic after any antibiotic use to repopulate the gut.

Use a prebiotic such as MOS to prevent attachment of less favourable bacteria

Summary



Exposure to the correct gut flora early in life will assist gut development

Water treatments will impact upon the gut flora by either killing the gut flora or altering the pH

Duodenum

Ileum

Feed quality and composition plays a major role in gut health

Gizzard

Caeca

If the development of the gut and the establishment of a healthy gut flora is disrupted the gut will not function correctly as the birds age.

If the gut flora is compromised it is essential to support its re-establishment

Any antimicrobial therapy will impact upon the gut flora and thus gut development

Subclinical and background challenges can cause a gut imbalance.

These must be understood

Thank you!

Questions?

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