Impact of nutrition on gut health and growth interaction in nursery pigs
营养对仔猪肠道健康和生长相互作用的影响

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Weaning: a life milestone for babies!
断奶：婴儿生命中的里程碑！

- Accustom to food other than its mother’s milk

要去习惯非母乳性其他食物。

Weaning: a life milestone for pigs as well!
断奶：对猪来说，也是生命中的里程碑！！

- Naturally, sows wean piglets at 8 to 12 weeks of age.
  按常理，仔猪断奶在8-12周。
- In pig production, we wean piglets at 2 to 4 weeks of age.　而我们选择在仔猪2-4周断奶。

Weaning: a life milestone for pigs as well!
断奶：对猪来说，也是生命中的里程碑！！

- Pigs are all stressed and tired from transportation.
  猪在运输过程中都会感到压力和疲劳。
- Dealing with new pen-mates 也要去应对新的“朋友”

Weaning: a life milestone for pigs as well!
断奶：对猪来说，也是生命中的里程碑！！

- And then…. forced to eat solid feed! 然后，被迫去吃固态饲料。

  …. which mostly includes starch and plant proteins.

  主要包括淀粉和植物蛋白。

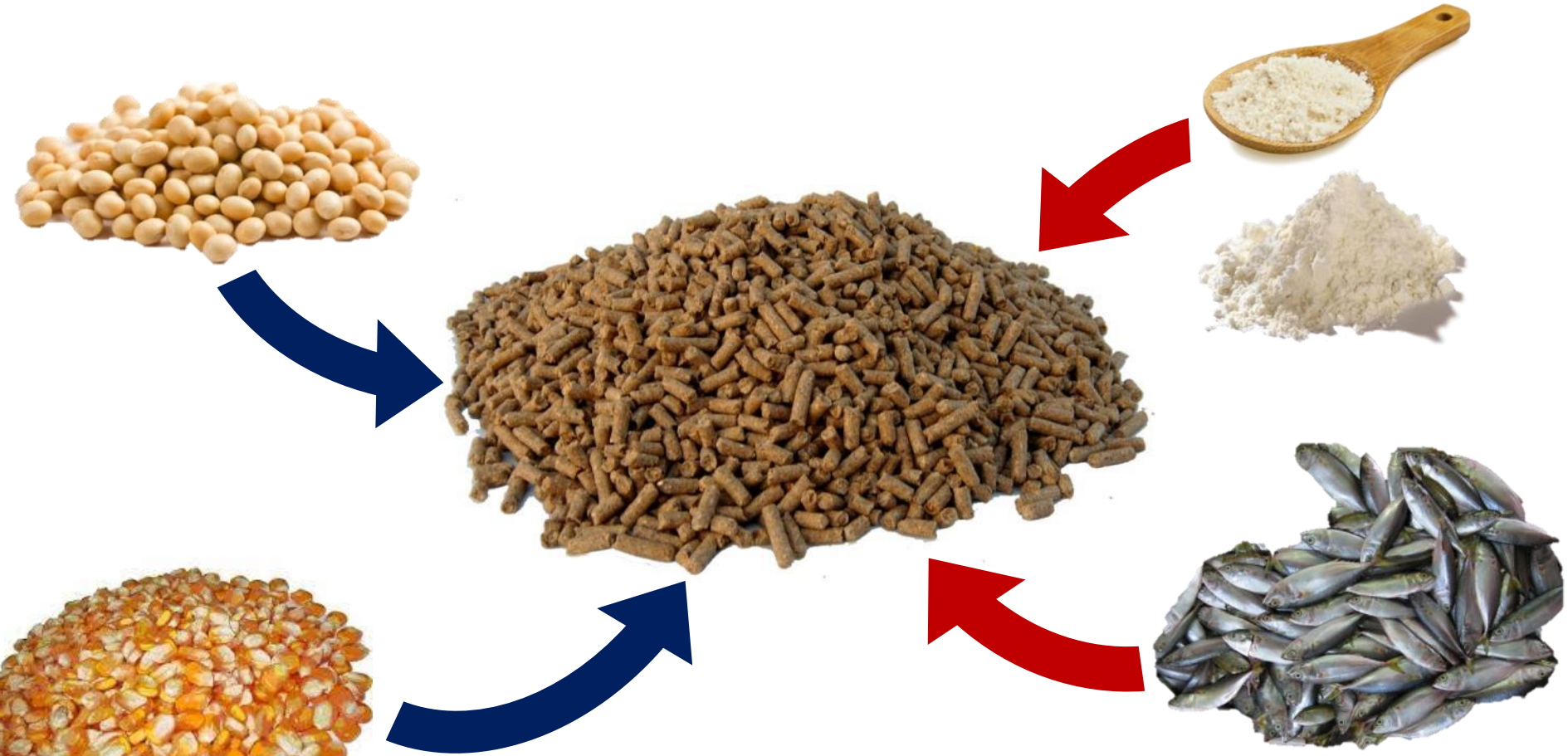
Weaning: what do we feed to piglets?
断奶：我们如何去喂养仔猪？

- Are they ready to eat your feeds? 它们做好吃你们饲料的准备了吗？
  - What are you feeding to newly weaned pigs? 你们给新断奶的猪喂什么？

Reality 现实

Wish 理想

Weaning: what do we feed to piglets?
断奶: 我们给仔猪饲喂什么？



Weaning: what do we feed to piglets?
断奶: 我们给仔猪饲喂什么？

- Feedstuffs from plants 源自植物的饲料

  - Protein supplements 蛋白补充物
    - Legume seed meals 各种豆粕
    - Co-products from grain milling and brewing 谷物碾磨和酿造的副产品
  - Energy feeds 能量饲料
    - Cereal grains 各种谷物
    - Oils 油脂

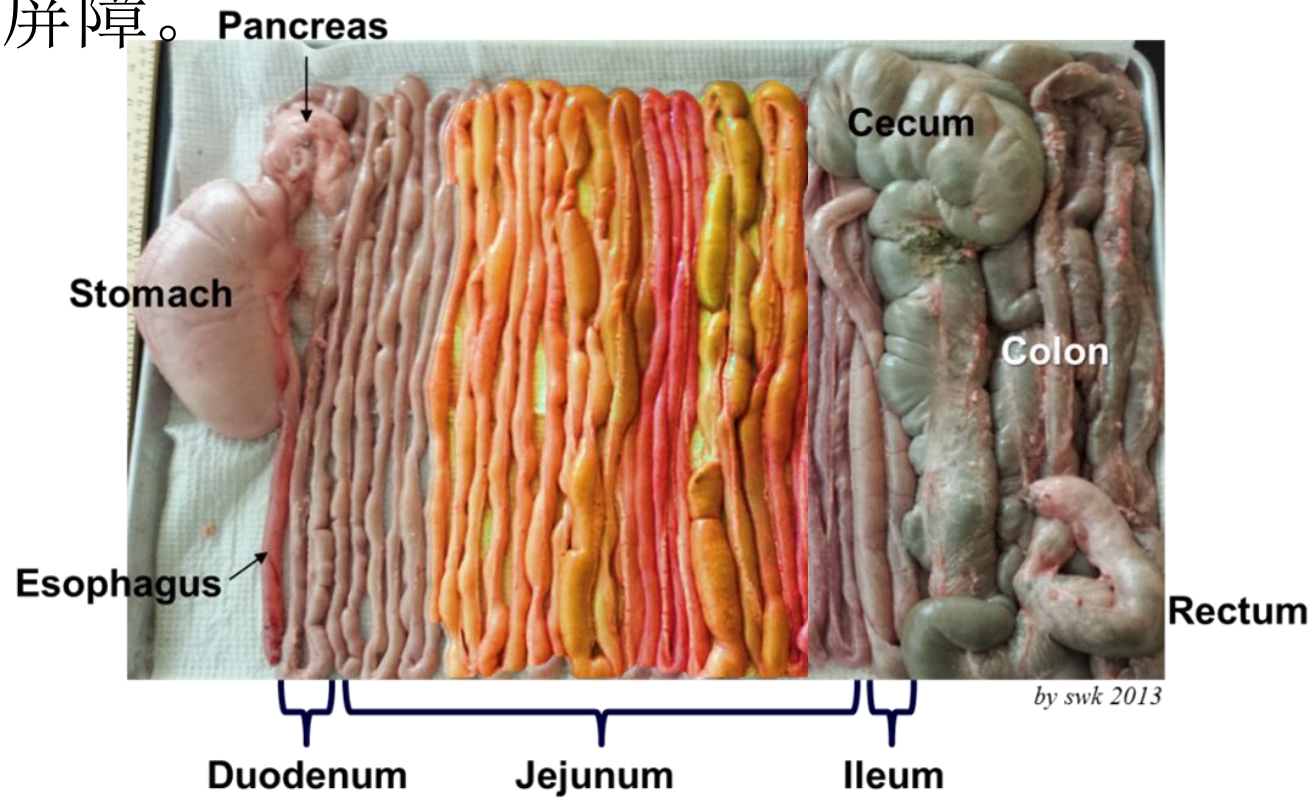
Weaning: what do we feed to piglets?
断奶: 我们给仔猪饲喂什么？

- Feedstuffs from animals 源自动物的饲料
  - Protein supplements 蛋白补充物
    - Meat meal, meat and bone meal 肉粉，肉骨粉
    - Blood plasma, blood meal 血浆，血粉
    - Fish meal 鱼粉
  - Energy feeds 能量饲料
    - Whey permeate, whey powder 乳清渗透物，乳清粉
    - Animal fat 动物油

The gut: gastrointestinal tract
肠道：胃肠道

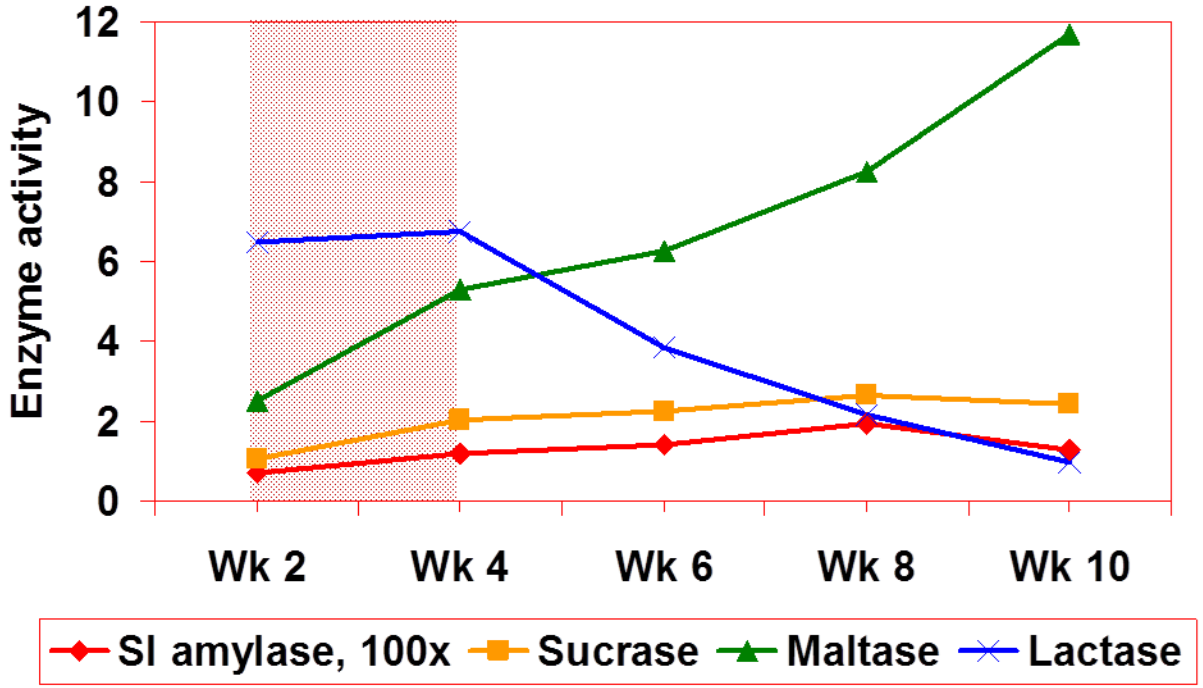
The gut: gastrointestinal tract
肠道：胃肠道

- The gut is the digestive tract but also first defense immune barrier. 肠道是消化道，也是第一道防御免疫屏障。



The gut: endogenous digestive enzymes
肠道：内源消化酶

- Activity of endogenous digestive enzymes changes.
  内源消化酶活性变化 饲料选择基于肠道的酶活性
  - Selection of feedstuffs based on available enzymes



Chapple et al., 1989

The gut: anti-nutritional compounds in feeds
肠道：饲料中的抗营养化合物

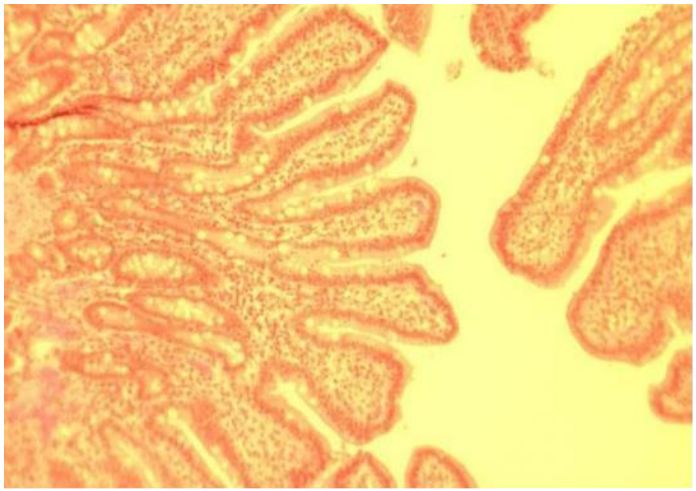
- Cereal grains and legume seeds contain ANC.
  谷物和豆类种子中含有抗营养化合物
  - ANC impairs gut health in newly weaned pigs.
    抗营养化合物会破坏新断奶的仔猪肠道健康。

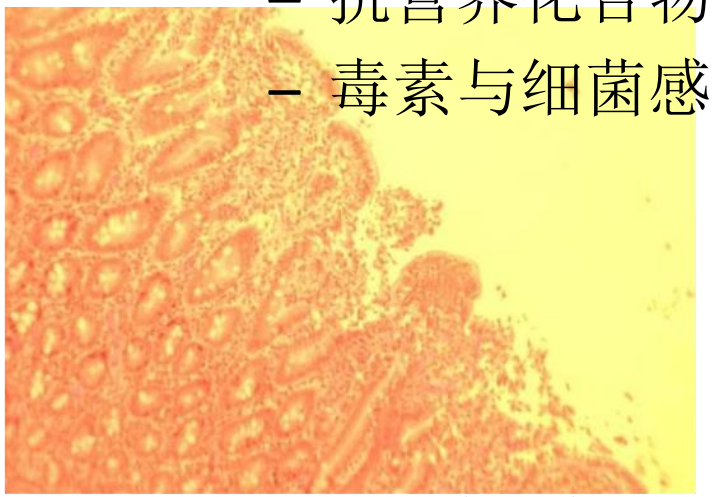
Soybean meals 豆粕 (legume-seed meals) 豆类种子粕	Trypsin inhibitor 胰蛋白酶抑制因子, lectin 凝集素, glycinin 大豆球蛋白
	β-conglycinin β-大豆球蛋白, sNSP
Canola meals 油菜籽粕	Goitrogen, sNSP 甲状腺肿, sNSP
Sorghum 高粱	Tannin 单宁, kafirins 醇溶谷蛋白
Cereal grains 谷物	Phytate 植酸, sNSP 可溶性非淀粉类多糖

The gut: challenges
肠道：挑战

- The gut is continuously challenged by:
  - Physical damages by feed particles
  - Anti-nutritional compounds
  - Toxins and bacterial infection

- 肠道不断受到挑战:
  - 饲料颗粒物理损伤
  - 抗营养化合物
  - 毒素与细菌感染





by swk 2003

The gut: challenges
肠道：挑战

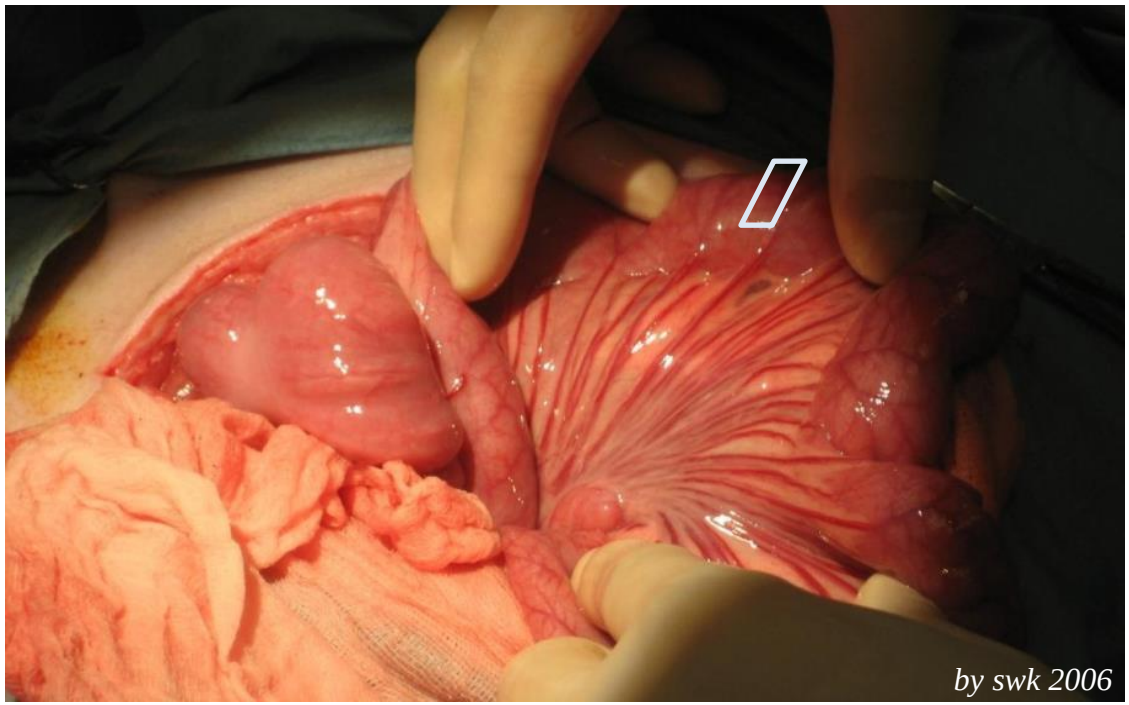
- All these foreign compounds could cause:
  - Disturbed gut integrity and gut leaking
  - Immunological and inflammatory responses
  - Oxidative damages in the gut
  - Increased pathogenic infection
- 所有这些外来化合物可能导致：
  - 干扰肠道完整性和肠道泄漏
  - 免疫和炎症反应
  - 肠道氧化损伤
  - 增加病原感染

The gut: challenges
肠道：挑战

- All these foreign compounds could cause:
  - Impaired gut morphology increasing cell proliferation
  - Impaired nutrient digestion and absorption
  - Finally reduced growth and health of nursery pigs
- 所有这些外来化合物可能导致：
  - 肠形态受损增加细胞增殖
  - 营养消化和吸收受损
  - 最后减少了仔猪的生长和健康

The gut: challenges
肠道：挑战

- The gut is the digestive tract but also first defense immune barrier. 肠道是消化道，也是第一道防御免疫屏障。



The gut: challenges
肠道：挑战

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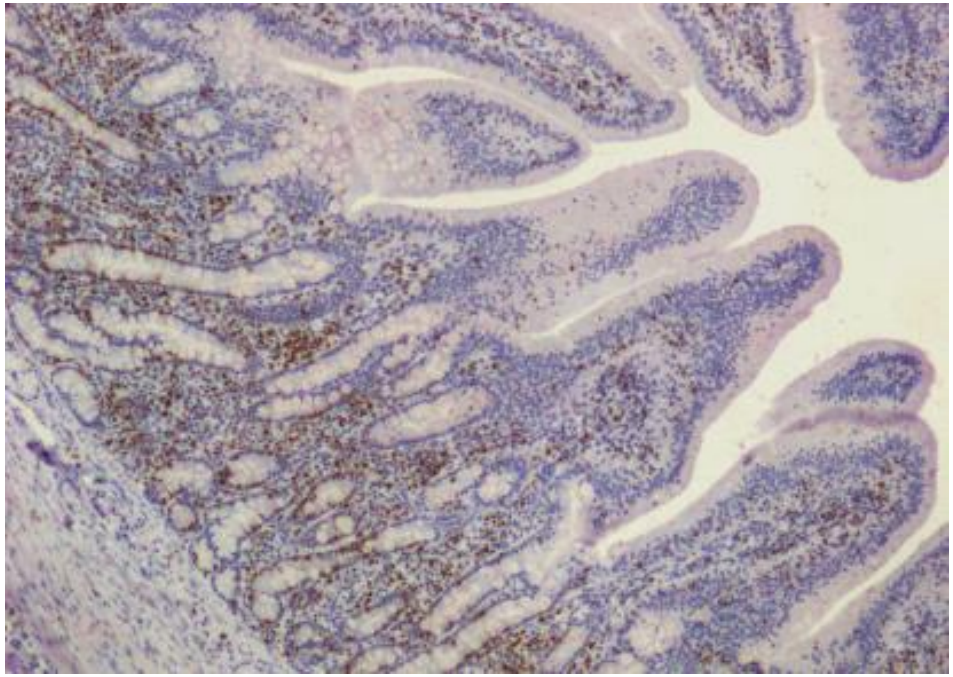
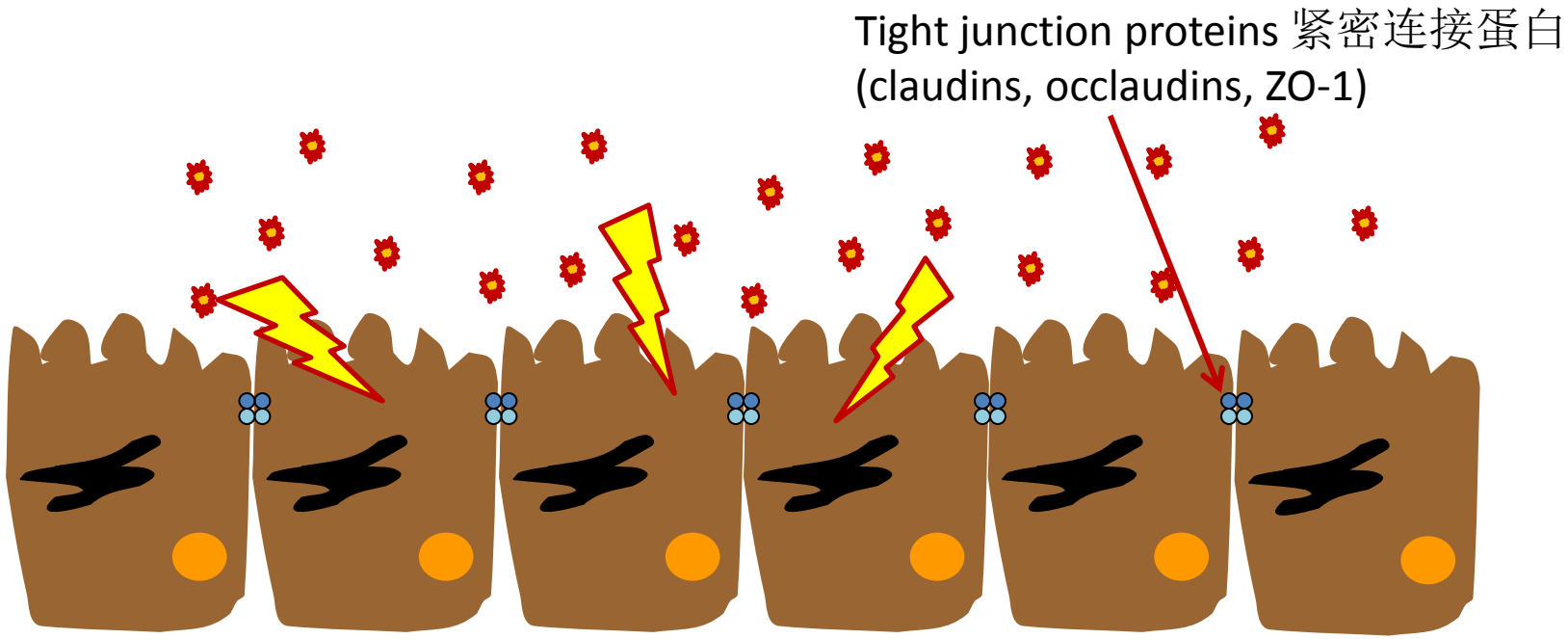


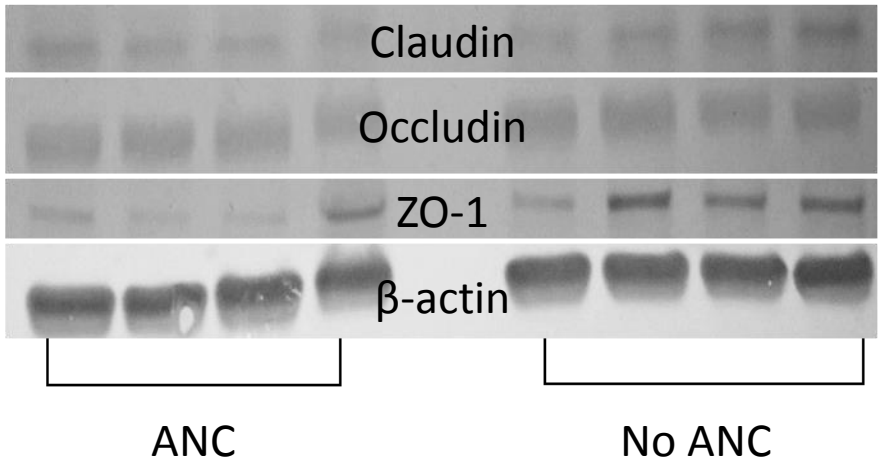
The gut: challenges
肠道：挑战

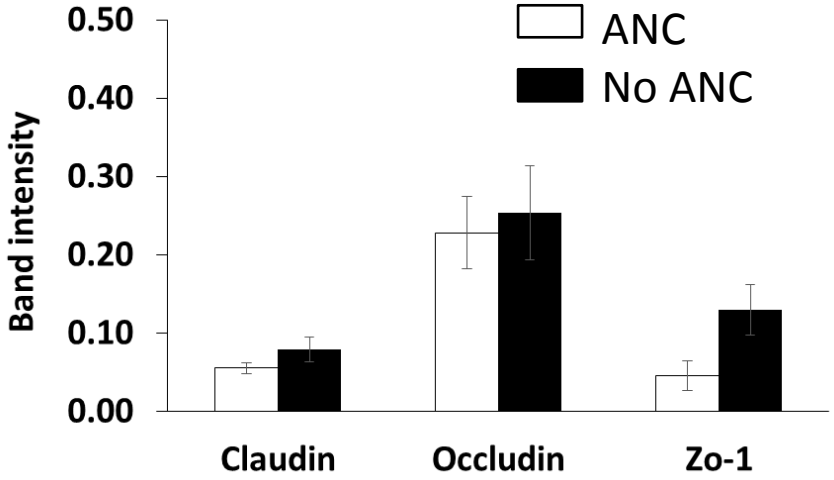
- Disturbed gut integrity and gut leaking
- 干扰肠道完整性和肠漏



The gut: challenges
肠道：挑战

- Disturbed gut integrity and gut leaking
  干扰肠道完整性和肠漏
  - Caused by anti-nutritional compounds (phytate)
    抗营养化合物引起的（植酸）

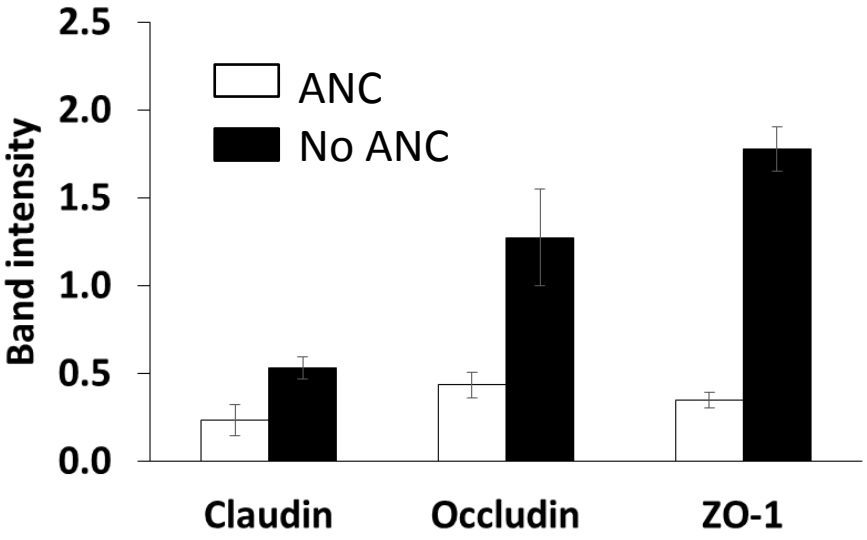


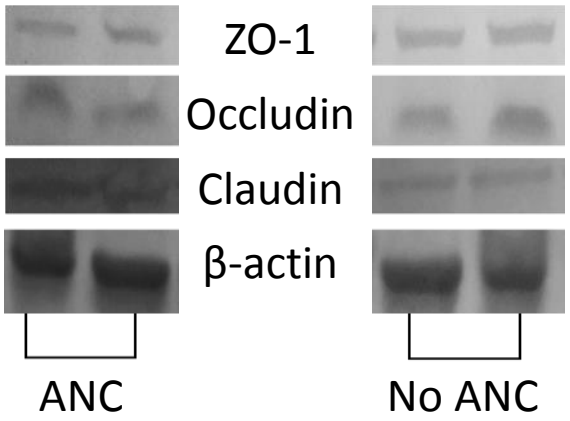


Lee et al. (2017) ASAS-MW

The gut: challenges
肠道：挑战

- Disturbed gut integrity and gut leaking
  干扰肠道完整性和肠漏
  - Caused by anti-nutritional compounds (sNSP)
    抗营养化合物引起的（sNSP）



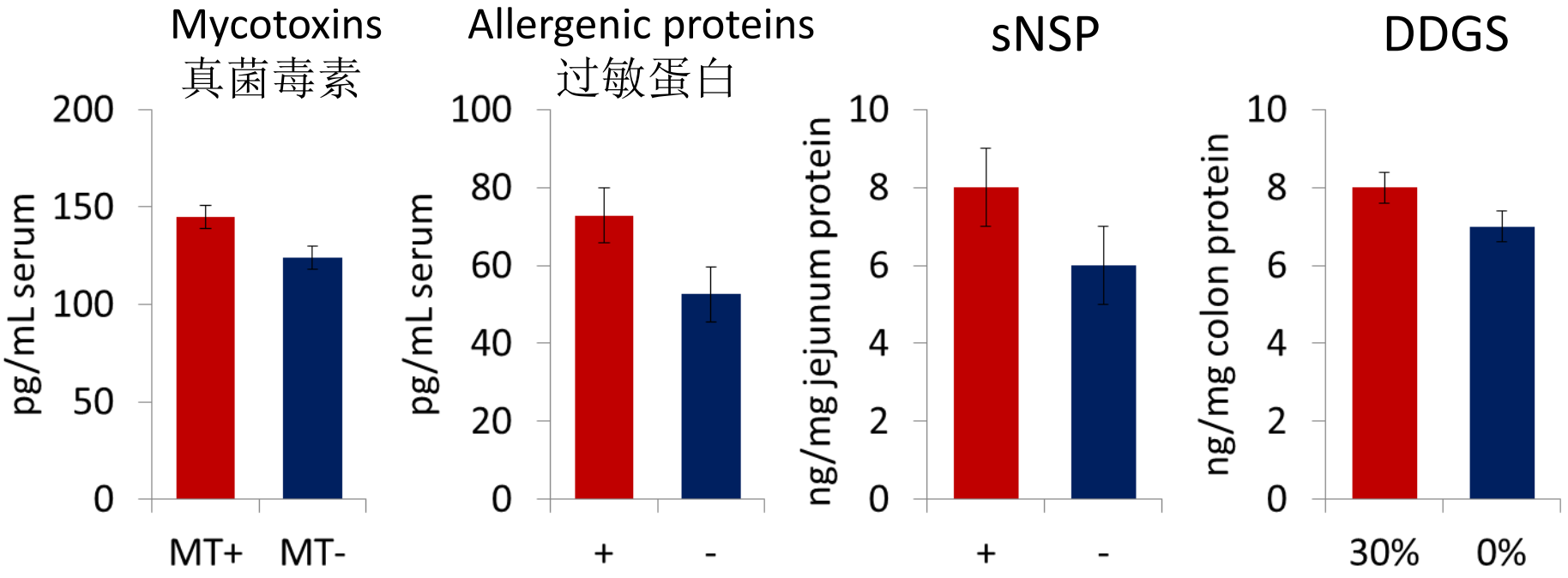


Chen et al. (2017) ASAS

The gut: challenges
肠道：挑战

- Immunological and inflammatory responses
  - Impact on TNF-α
    对肿瘤坏死因子**α** 的影响

免疫和炎症反应

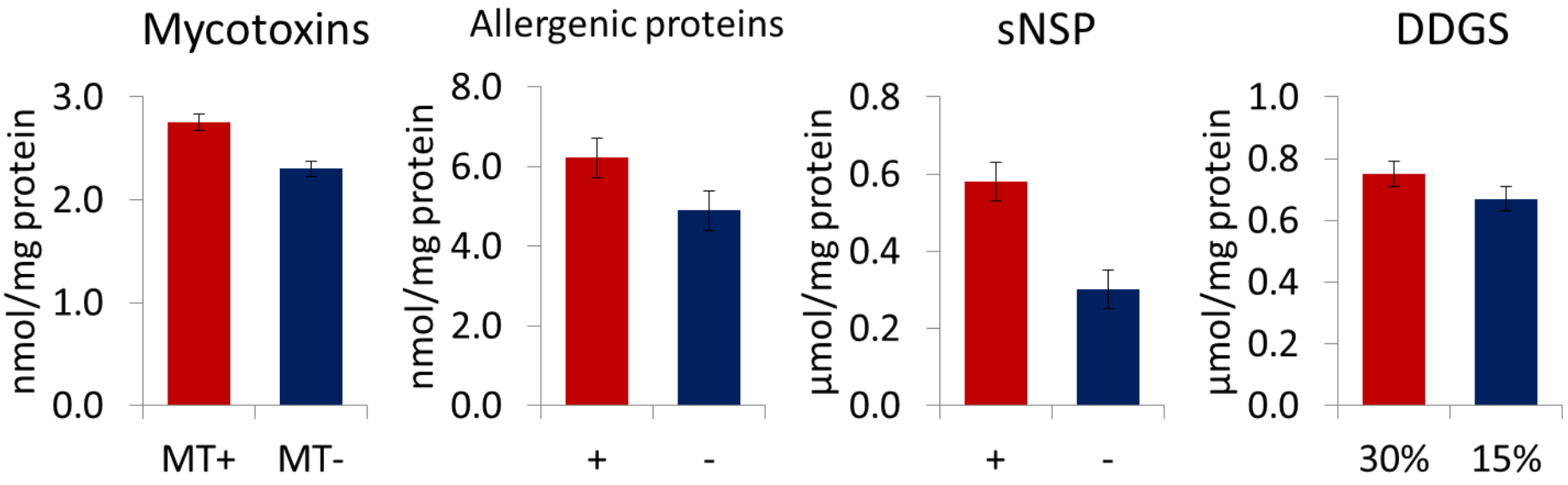


The gut: challenges
肠道：挑战

- Oxidative damages in the gut 肠道氧化损伤
  - Impact on oxidative stress markers
    氧化应激标记物的影响

Protein carbonyls 蛋白质羰基

Malondialdehyde 丙二醛

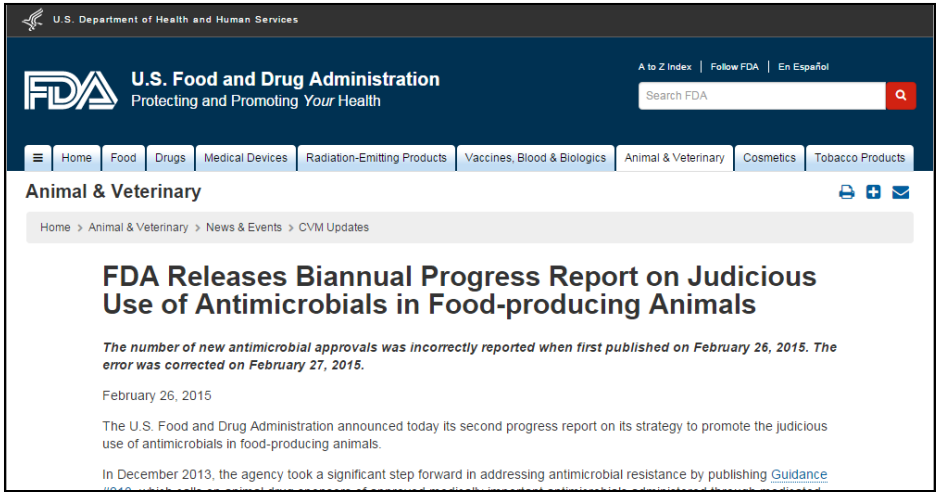


The gut: challenges
肠道：挑战

- Increased pathogenic infection
  - Enterotoxigenic E. coli: F 5, F6, F18 fimbriae
  - Coronavirus: TGE, PED
  - Clostridia ssp. (*Clostridium perfringens* A and C)
  - Isospora suis: a protozoan parasite
  - Salmonella (*Salmonella typhimurium*)
- 增加病原感染
  - 产肠毒素大肠杆菌-F 5/F6/F18菌毛
  - 冠状病毒：TGE、PED
  - 产气荚膜梭菌 A和C
  - 猪等孢球虫：原生动物寄生虫
  - 沙门氏菌

The gut: challenges
肠道：挑战

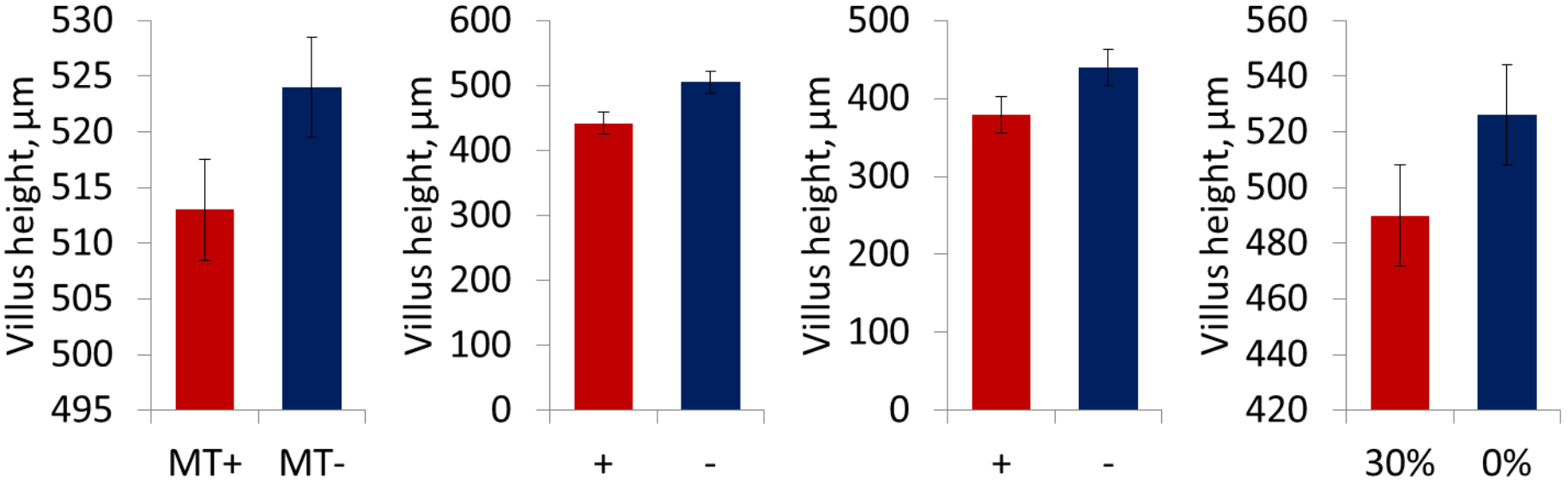
- Antimicrobial growth promoters (AGP) have been successful reducing pathogenic infection through the gut in pigs. However, AGP is banned in animal feeds.
抗菌生长促进剂（AGP）已成功通过在猪肠道减少病原感染。然而，AGP是禁止用在动物饲料。
  - EU (2007)
  - Korea (2011)
  - USA (2017)
  - Who is next?



The gut: challenges
肠道：挑战

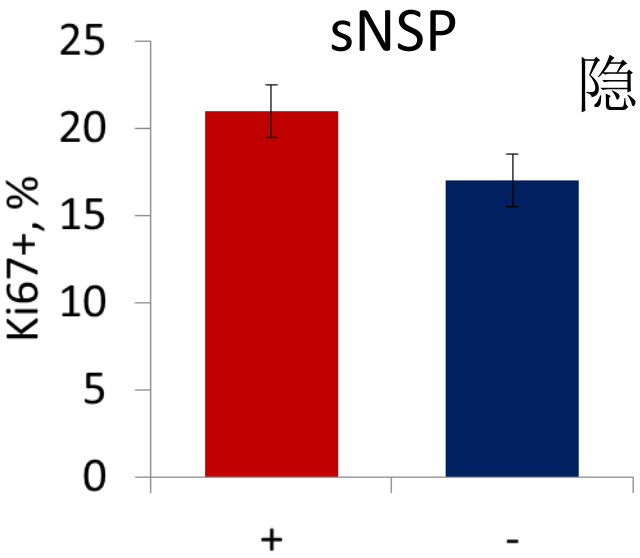
- Impaired gut morphology increasing cell proliferation
  肠形态受损增加细胞增殖

Mycotoxins 真菌毒素 | Allergenic proteins 过敏蛋白 | sNSP 可溶解非淀粉多糖 | DDGS

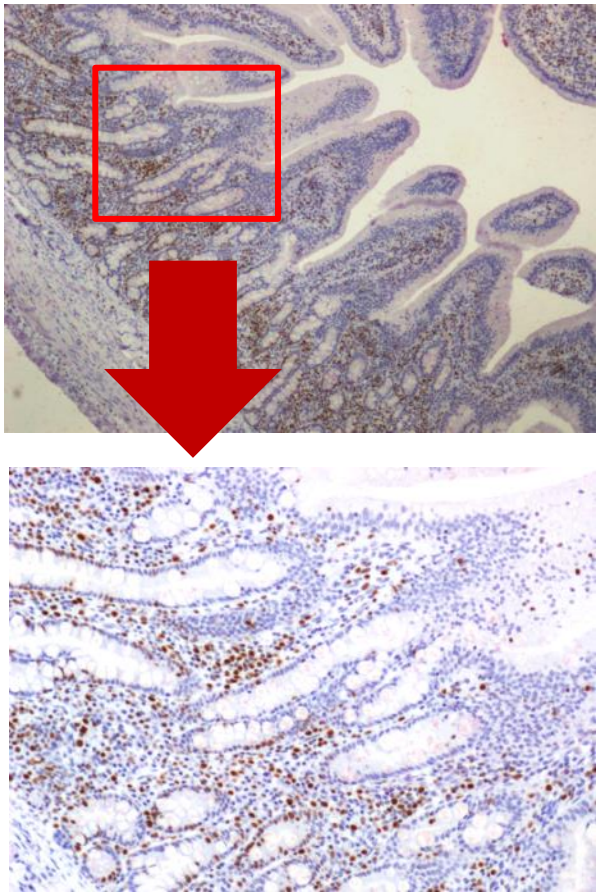


The gut: challenges
肠道：挑战

- Impaired gut morphology increasing cell proliferation
  肠形态受损增加细胞增殖
  - Immunohistochemistry
  - Ki67+ cells in the crypt

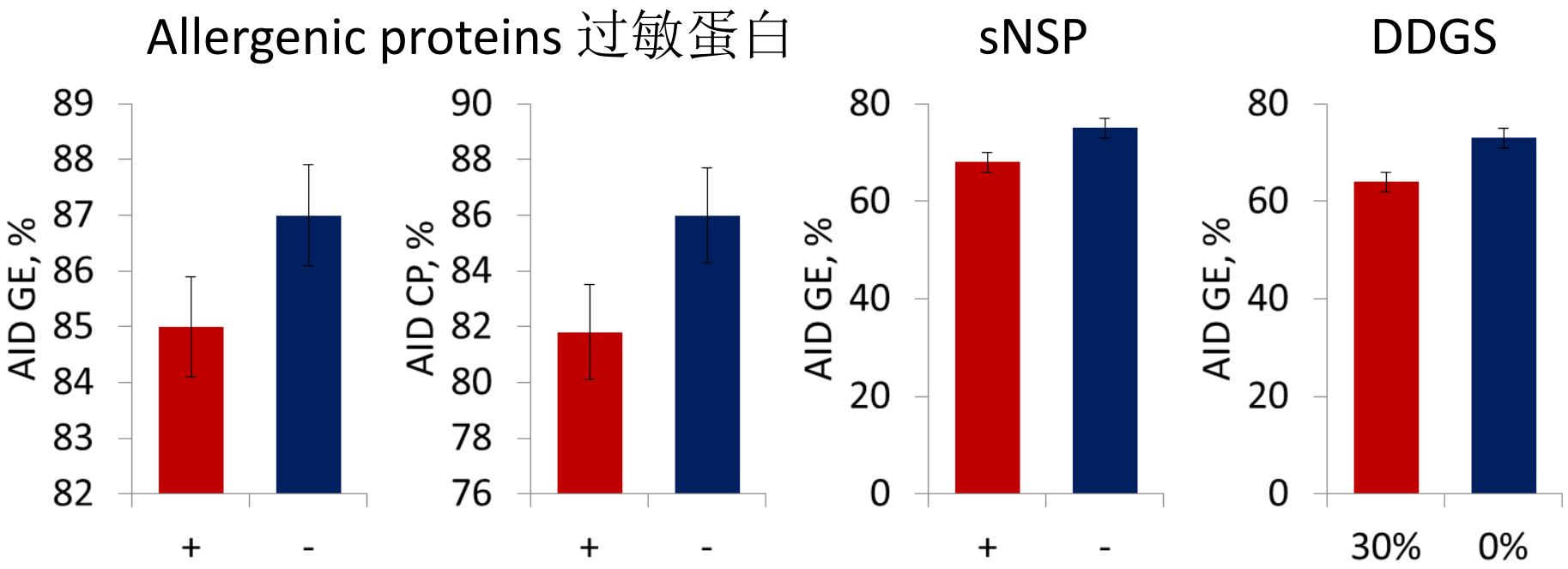


隐窝中的Ki67 +细胞



The gut: challenges
肠道：挑战

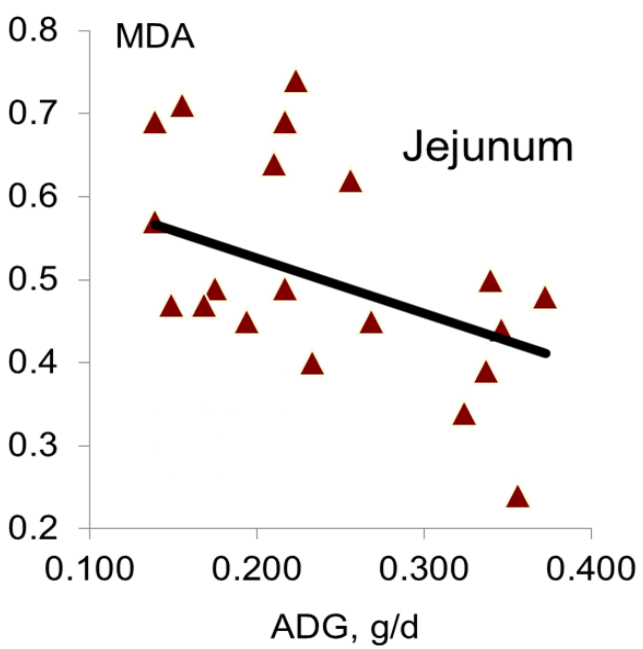
- Impaired nutrient digestion and absorption
  营养消化和吸收受损

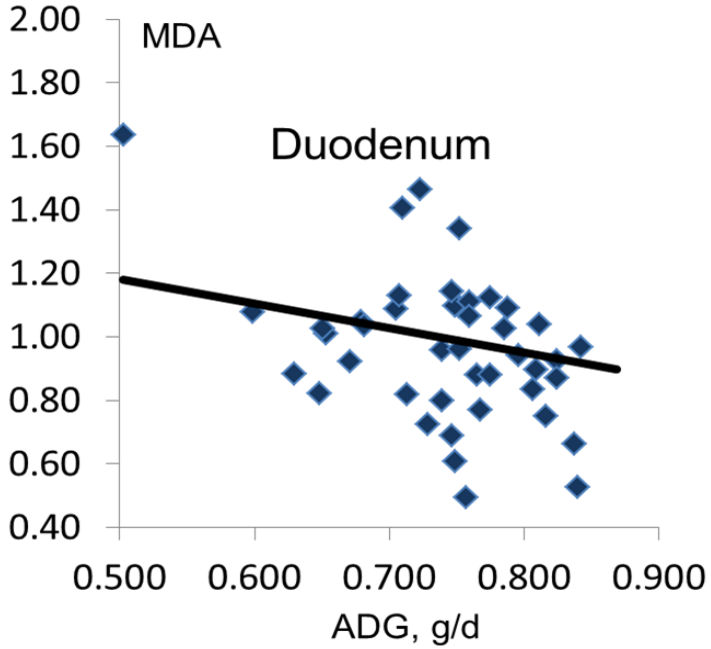


The gut: oxidative stress
肠道：氧化应激

- Finally reduced growth and health

  最后减少了生长和健康





Feeding newly weaned pigs
喂养新断奶仔猪

- Feedstuffs should be carefully selected.
  饲料应当精心挑选
  - Substrates for endogenous digestive enzymes
    与内源性消化酶匹配
  - Anti-nutritional compounds 抗营养化合物

Feeding newly weaned pigs
喂养新断奶仔猪

- Use of right feedstuffs will help with:
  - Enhancing gut integrity and reducing gut leaking
  - Reduce unnecessary inflammatory responses
  - Reduce oxidative damages in the gut

- 使用正确的饲料会帮助：
  - 增强肠道完整性，减少肠漏
  - 减少不必要的炎症反应
  - 减少肠道氧化损伤

Feeding newly weaned pigs
喂养新断奶仔猪

- Use of right feedstuffs will help with:
  - Reduce pathogenic infection through the gut
  - Improve gut morphology
  - Increase nutrient digestion and absorption
  - Finally improve growth and health of nursery pigs
- 使用正确的饲料会帮助：
  - 减少肠道致病性感染
  - 改善肠道形态
  - 增加养分消化吸收
  - 最后提高仔猪的生长和健康

Feeding newly weaned pigs
喂养新断奶仔猪

- Feedstuffs from animal tissues or products have extensively been used in feeding newly weaned pigs.
  - High digestibility
  - Absence of anti-nutritional compounds
- 从动物组织生产的产品已广泛应用于饲料饲喂断奶仔猪。
  - 高消化率
  - 无抗营养物质

Feeding newly weaned pigs
喂养新断奶仔猪

- Protein supplement: blood plasma, fish meal, dried whole milk, dried skim milk, whey protein concentrate, dried cheese products
- Energy feed: whey permeate, whey powder
- 蛋白质原料：血浆，鱼粉，全脂奶粉，脱脂奶粉，乳清浓缩蛋白，奶酪粉
- 能量饲料：乳清渗透，乳清粉

Feeding newly weaned pigs
喂养新断奶仔猪

- Protein supplement (5 to 7 kg BW):
  蛋白质的补充（5至7公斤体重）
  - Soybean meal: max 20%　豆粕：最大20%
  - Fish meal: max 7%　鱼粉：最大7%
  - Blood plasma: max 7%　血浆：最大7%
  - Poultry meal: 5 to 7%　禽肉粉：5至7%
  - Supplemental AA: L-Lys HCl (max 0.5%)
    补充：L-赖氨酸盐酸盐（最大0.5%）

Feeding newly weaned pigs
喂养新断奶仔猪

- Energy feed (5 to 7 kg BW):
  能量饲料（5至7公斤体重）
  - Whey permeate: min 22%
    低蛋白乳清粉（乳清渗透）： 最少22%
  - Cook meal / bakery byproducts: 5 to 10%
    烘焙业副产品：5至10%

Feeding newly weaned pigs
喂养新断奶仔猪

Feedstuff, %	5 to 7 kg	7 to 11 kg	
Corn, yellow dent 玉米	34	51	Lactose / Energy
Whey permeate 乳清渗透物	**22**	**10**	— 乳糖/能量
Cookie meal 饼干粉	**10**	**5**	— Energy 能量
Soybean meal 豆粕	19	23	
Poultry meal 禽肉粉	**6**	**3**	Protein 蛋白
Blood plasma 血浆	**3**	**2**	
Fish meal 鱼粉	**4**	**2**	
L-Lys HCl	0.45	0.48	
DL-Met	0.20	0.20	
L-Thr	0.15	0.15	
Others	2.20	3.17	
Total	100.00	100.00	

EXAMPLE ONLY 仅仅举例

Conclusion 结论

- The gut of newly weaned pigs is not fully mature and its health can easily be impaired reducing growth.
- 新生断奶仔猪的肠道尚未完全成熟，其健康状况极易受损，降低其生长。

Conclusion 结论

- Consideration of selecting feedstuffs is critical for the gut health and finally growth of newly weaned pigs.
- 为了肠道健康和断奶仔猪的生长， 选择合适的饲料原料是非常重要的。

Conclusion 结论

- Use of feedstuffs with allergenic proteins and anti-nutritional compounds should be limited in feeding newly weaned pigs.
- 断奶仔猪日粮中使用含有致敏蛋白和抗营养化合物的饲料应该受到限制。

Thank you!

Thoughts? Questions?