

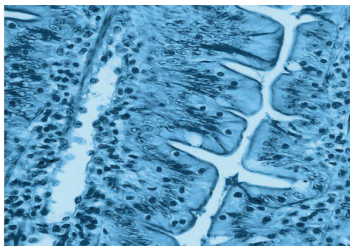

Modelling the effect of heat stress on nutritional requirements of the sow

Jan Fledderus

Knowhow to feed

This presentation

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- Developments in piglet production and sow body composition
- Importance of high feed intake for milk production
- Feeding schedule and diet composition in lactation
- Heat stress
- Modelling to calculate effect of heat stress on nutrient requirements

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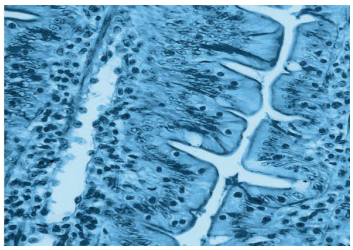

Developments in piglet production and sow body composition

Knowhow to feed

Development in piglet production
Average litter size in The Netherlands

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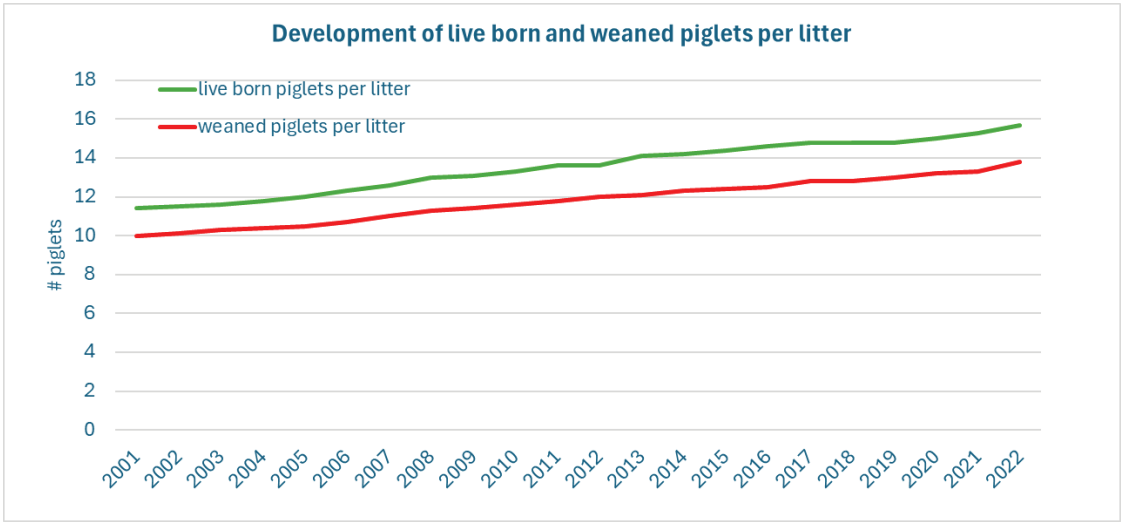
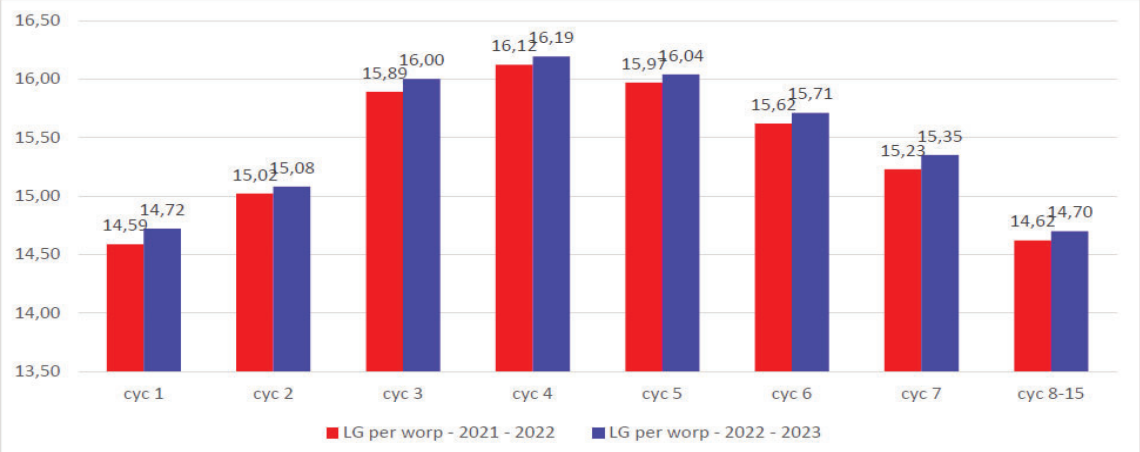


NL Agrovision 2023

Development in piglet production

Effect of parity and annual improvement in litter size



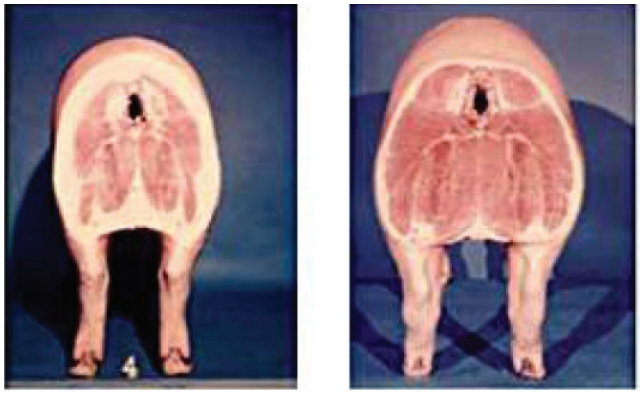
Live born piglets per litter

- Maximum profitability when the sow are producing at least 6 litters

Development in sow body composition

- New target values for body weight and back fat

- Lean sows = adjusted requirements
  - Amino acids
  - Energy
  - Digestible P
  - Calcium



Modern sows are lean

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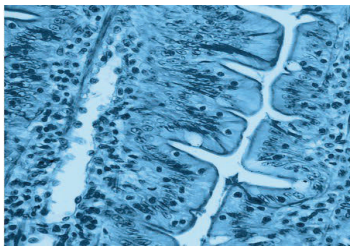

Importance of high feed intake during lactation

Knowhow to feed

Main factors affecting milk production

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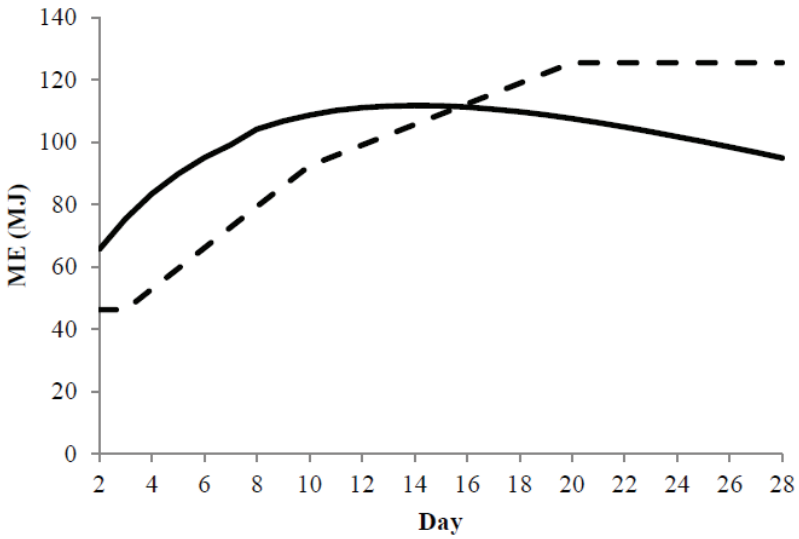
- Genetic improvements
- Vitality of the suckling piglets
- Litter size
- Parity
- Farming conditions (health, stress...)
- Individual variability
- Heat stress
- **Nutrient consumption**
  - **Water**
  - **Net energy**
  - **SID Amino acids**
  - **Minerals**

Development of energy output for milk production (—) and energy intake (----)



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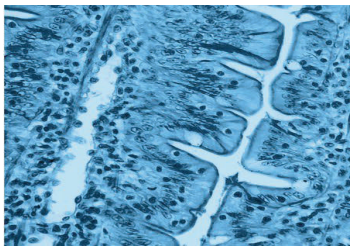
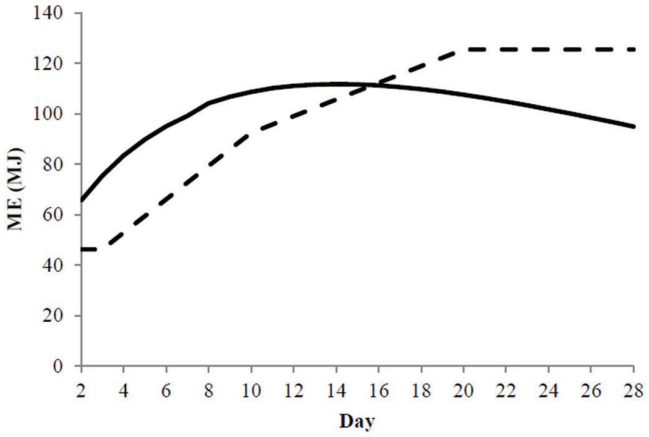
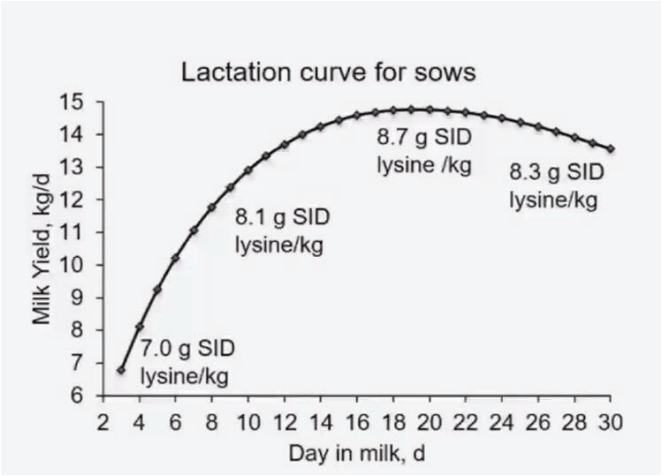


Feeding schedule and diet composition in lactation

What is the optimum diet composition?
Effect of SID lysine

Milk production (—)
Feed intake (----)





K. Højgaard, 2020

What is the optimum diet composition?
Effect of source of Net Energy?

Net Energy value, kcal/kg	2290	2290	2290
Starch, g/kg	300	340	380
Fat, g/kg	80	68	55

SFR trial report no. 320

What is the optimum diet composition?
Effect of source of Net Energy?

Net Energy value, kcal/kg	2290	2290	2290
Starch, g/kg → stimulates insulin	300	340	380
Fat, g/kg	80	68	55
Feed Intake, kg/day	6.7	6.7	6.8
Weight loss, kg	15	11	10
Back fat loss, mm	3.1	2.7	2.3
Milk fat, %	7.5	7.2	7.0
ADG piglets, g/d	260	280	270

What is the optimum diet composition?
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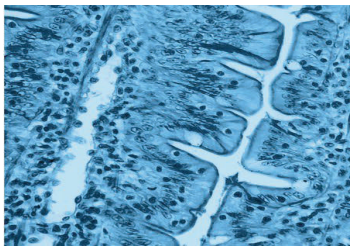
What is the recommended feeding schedule?

	Day	Feed level, kg
Gestation diet	0-39	3.0
	40-79	2.7
	80-108	3.2
Lactation / Transition diet	109 – 112	3.2
	113 – 115	2.5
	1	2.5
	2	3.0
	3	3.5
	4	4.0
	5	4.0
Lactation diet	6	4.5
	7	5.0
	8	5.5
	9	6.0
	10	6.5
	11	7.0
	day 12-weaning	1% BW+ 0.5 kg/piglet

BW = body weight of the sow at farrowing





Heat stress

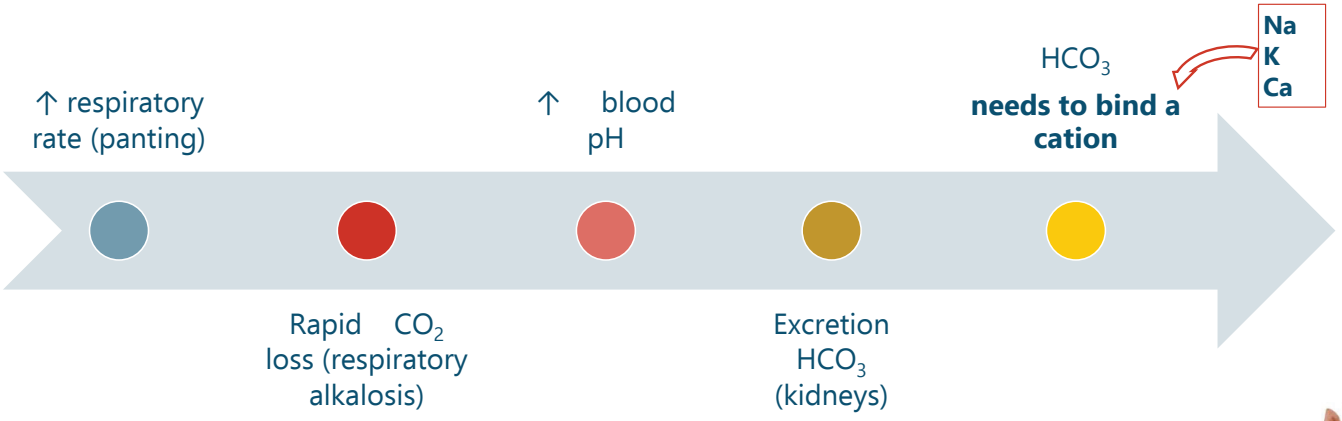
Optimum temperatures for sows

Animal	Optimum °C (°F)	Desirable Limits °C
Gestating sows	18 (65)	10 - 27
Lactating sows	18 (65)	13 - 27

Heat has to be "excreted"

- Via radiation, conduction, convection, evaporation
- The pig tries to avoid increased temperatures
  - Change metabolism
  - Reduce insulin sensitivity
  - Reduce feed intake
- Pigs cannot sweat
  - Dirty pens to increase heat excretion through the skin
  - Panting to increase heat excretion by evaporation through the respiratory tract

Panting increases cation requirement



Respiratory alkalosis increases cation excretion

Excretion in urine during 12 hours (mg/kg BW)

	Thermoneutral	Heat stress
Na	6.4	11.0
K	26.0	54.2
Ca	1.8	4.0
Cl	18.9	11.3

Belay et al., 1992

Effect of energy source on heat production (kcal/kg)

	starch	protein	fat
Gross Energy (GE)	4486 (100)	5489 (122)	9283 (207)
Digestible Energy (DE)	4176 (100)	4916 (118)	8424 (202)
Metabolisable Energy (ME)	4176 (100)	4295 (103)	8424 (202)
Net Energy (NE)	3436 (100)	2434 (71)	7517 (219)
Heat Production (kcal/kg)	740	1861	907
Heat Production (% of NE)	22%	76%	12%

Noblet, 1994

Effect of heat stress for lactating sows
meta analyses

- Literature: 38 publications & 227 observations
  - Equations to predict the effect of heat stress
  - Primiparous and multiparous sows
- Different response parameters
  - Feed intake during lactation
  - Milk production
  - Sow body weight and back fat
  - Piglet and litter growth
  - Respiratory rate and body temperature
- Linear or quadratic response models

Dourmad et al., 2022

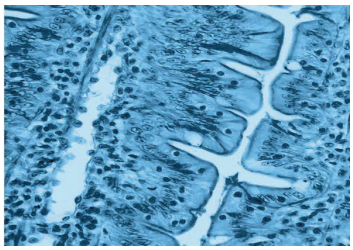
Effect of heat stress for lactating sows
meta analyses

Results expressed per °C above upper critical body temperature

parity		primiparous	multiparous
feed intake	kg/d	-0.13	-0.20
litter growth rate	g/d	-33	-46
body weight loss	kg	0.46	0.76
back fat loss	mm	0.084	0.084

Dourmad et al., 2022





Modelling to understand the effect of heat stress on nutrient requirement of the sow

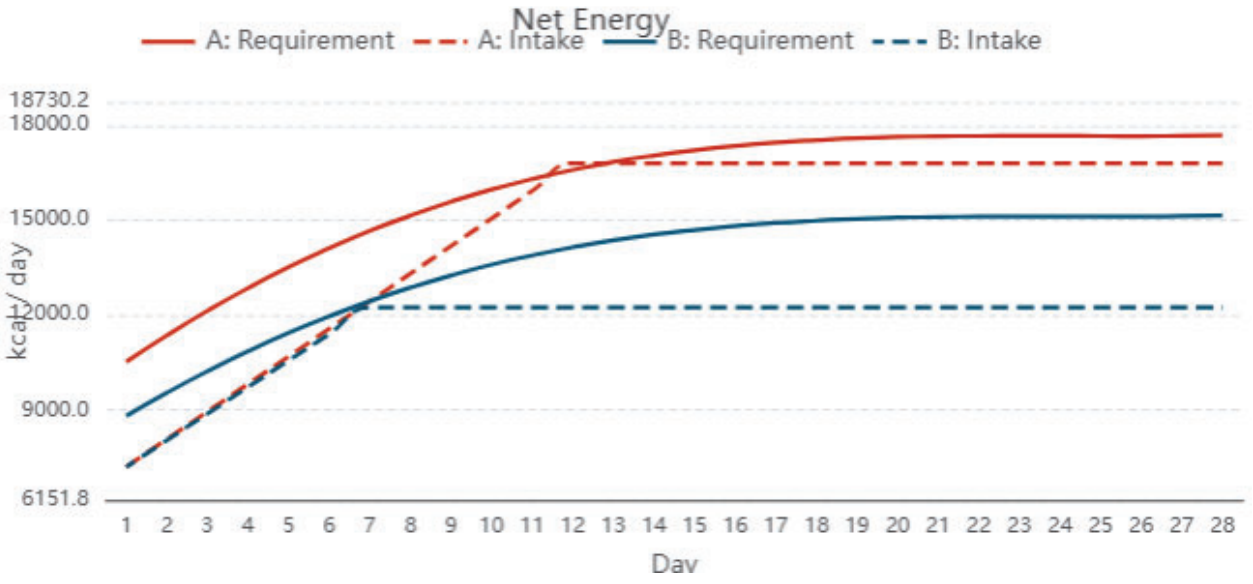
SFR SowModel®, 2025

- Calculating nutrient requirements in gestation and lactation
- Taking into account:
  - Parity
  - Litter size & weaning age
  - Piglet body weight at birth and at weaning
  - Sow body weight and back fat mobilisation
  - Recovery from previous lactation
  - Feed intake (effect of heat stress)

SowModel® : input, based on Dourmad, 2022

Parity	Primiparous		Multiparous	
Scenarios	**Thermo-neutral**	**Heat stress**	**Thermo-neutral**	**Heat stress**
Performance of lactating sows				
Body weight at transition to farrowing (kg)	230	230	270	270
Back fat at transition to farrowing (mm)	16	16	15	15
Body weight at weaning (kg)*	190	185	230	222
Back fat at weaning (mm)*	11	10	11	10
Total number of born piglets	16	16	17	17
Number of weaned piglets	14	14	15	15
Weaning age	28	28	28	28
Performance of suckled piglets				
Birth weight (kg)	1.25	1.25	1.40	1.40
Weaning weight (kg)	7.45	6.79	7.37	6.51
Litter growth rate (kg/d)*	3.10	2.77	3.20	2.74
Feeding schedule during lactation				
Feed intake at start of lactation (kg/d)	3	3	3	3
Maximum feed intake (kg/d)*	7.0	5.1	8.0	5.2
Day of reaching maximum daily feed intake*	12	7	12	7

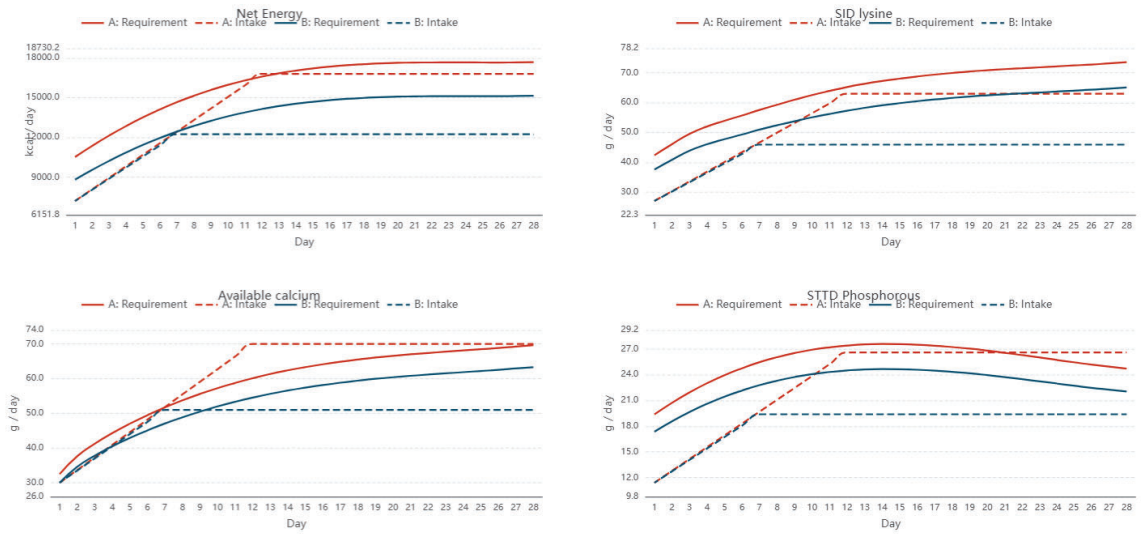
SowModel® : output graphs lactation



SowModel® : output graphs lactation

Lactation

Scenario A: Thermoneutral **Scenario B:** 10°C heat stress



SowModel® : output calculated optimum nutrient content in lacting sow feed

Parity	Primiparous		
Scenarios	Thermo-neutral	Heat stress	Δ° (%)
Net energy (kcal/kg feed)	2482	2935	18
SID Lysine (g/kg feed)	9.9	12.0	21
SID Lysine/net energy (g/Mcal)	4.00	4.09	+2.5
Available calcium (g/kg feed)	10.0	12.1	21
STTD phosphorus (g/kg feed)	3.9	4.8	23
Available calcium/STTD Phosphorus	2.56	2.52	-1.7

SowModel® : output calculated optimum nutrient content in lacting sow feed

Parity	Primiparous			Multiparous		
Scenarios	Thermo-neutral	Heat stress	Δ° (%)	Thermo-neutral	Heat stress	Δ° (%)
Net energy (kcal/kg feed)	2482	2935	18	2386	3007	26
SID Lysine (g/kg feed)	9.9	12.0	21	8.9	11.3	27
SID Lysine/net energy (g/Mcal)	4.00	4.09	+2.5	3.73	3.76	+0.8
Available calcium (g/kg feed)	10.0	12.1	21	9.2	2.1	32
STTD phosphorus (g/kg feed)	3.9	4.8	23	3.6	4.7	31
Available calcium/STTD Phosphorus	2.56	2.52	-1.7	2.56	2.57	+0.7

- Nutritional requirements (per kg of feed) increased during 10°C heat stress:
  - Primiparous sows: + 21%
  - Multiparous sows: + 29%
- No effect on AA/NE and Ca/P ratios

Feed measures to reduce the impact of heat stress

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- Feed management lactating sows
  - Ad-libitum water supply
  - Pelleted feed
  - Feed in cool parts of the day
  - At least three meals per day

- Diet composition
  - Formulate on Internal Heat Production
  - Compensate for cation loss
  - Additional adjustments, including anti-oxidants and additives
  - Modelling to understand the effect of heat stress on nutrient requirements

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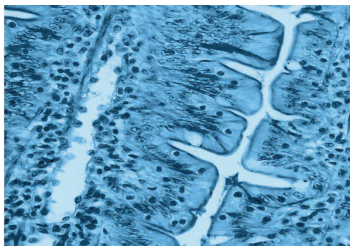

Thank you for your attention

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