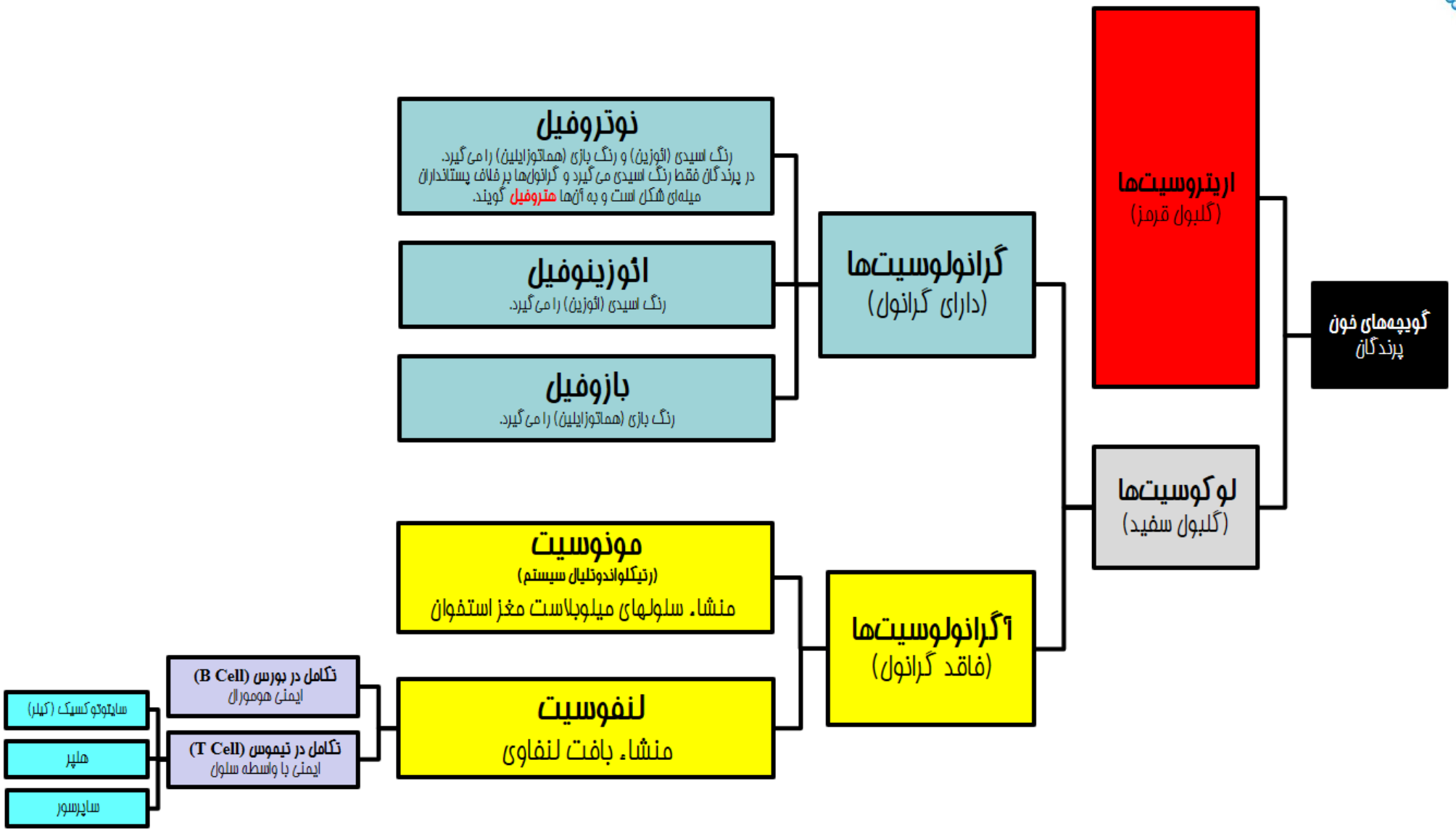
8th International Veterinary Poultry Congress

# Mitigating the effects of ascites syndrome in a susceptible broiler strain

Speaker: M. Zaghari
mzaghari@ut.ac.ir

Available at: www.minatoyoor.com

# Overview of Blood Components



## غلظت اجزای تشکیل‌دهنده خون در پرندگان و پستانداران

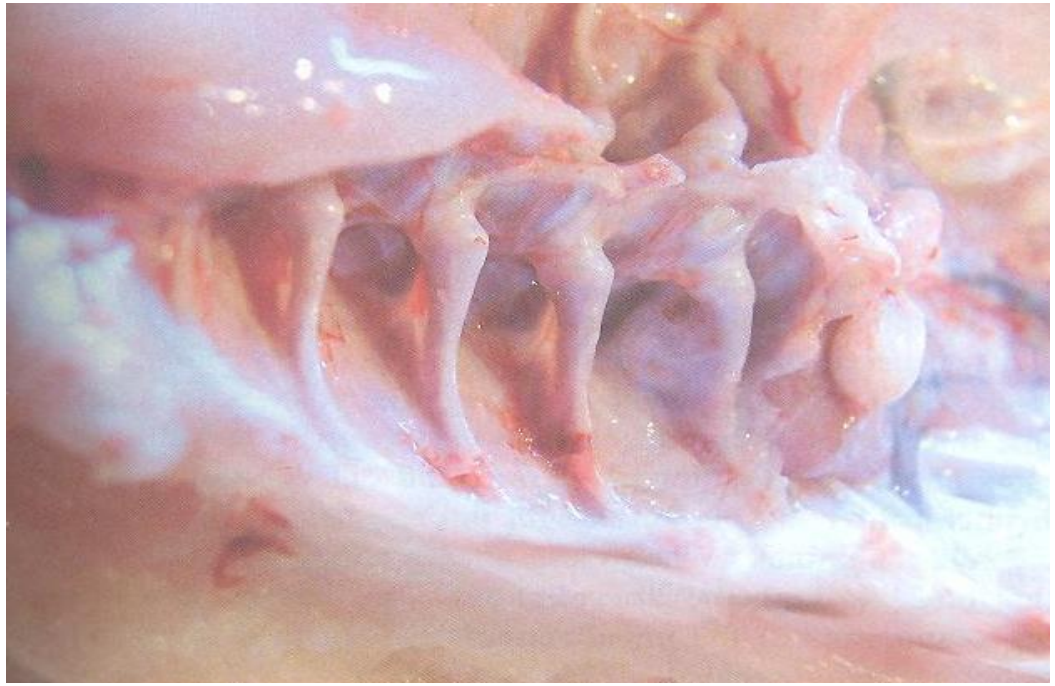
| متغیر / نوع حیوان | مرغ | گاو | گوسفند | اسب |
|---|---|---|---|---|
| گویچه‌های قرمز ($\times 10^6$) | ۳ | ۷ | ۱۲ | ۹ |
| هماتوکریت (٪) | ۳۰ | ۳۵ | ۳۵ | ۴۱ |
| هموگلوبین (meq/L) | ۹ | ۱۱ | ۱۱/۵ | ۱۴/۴ |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] (meq/L) | [illegible] | [illegible] | [illegible] | [illegible] |
| اسیدلاکتیک (meq/L) | ۴۷-۹۸ | ۵-۲۰ | ۹-۱۲ | ۱۰-۱۶ |
| کلسترول (meq/L) | ۱۲۵-۲۰۰ | ۸۰-۱۸۰ | ۶۰-۱۵۰ | ۷۵-۱۵۰ |
| سدیم (meq/L) | ۱۵۱-۱۶۱ | ۱۳۲-۱۵۲ | ۱۳۹-۱۵۲ | ۱۳۲-۱۵۲ |
| پتاسیم (meq/L) | ۴/۶-۴/۷ | ۳/۹-۵/۸ | ۳/۹-۵/۴ | ۲/۵-۵ |
| کلر (meq/L) | ۱۱۹-۱۳۰ | ۹۷-۱۱۱ | ۹۵-۱۰۵ | ۹۹-۱۰۹ |

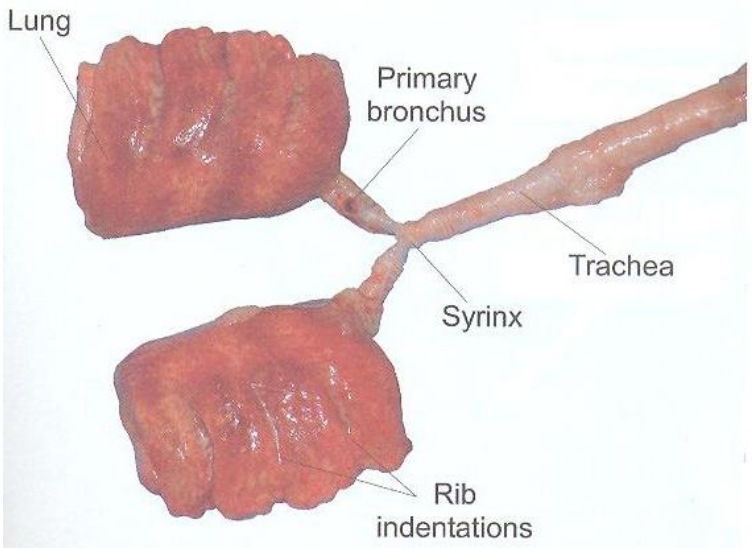
- تعداد گلبول قرمز در طیور کمتر است
- میل ترکیب اکسیژن با گلبول قرمز طیور کمتر است
- طول عمر اریتروسیت ها ۳۰ تا ۴۰ روز
- اریتروسیت های مرغ دارای هسته هستند و انعطاف پذیری اندکی دارند

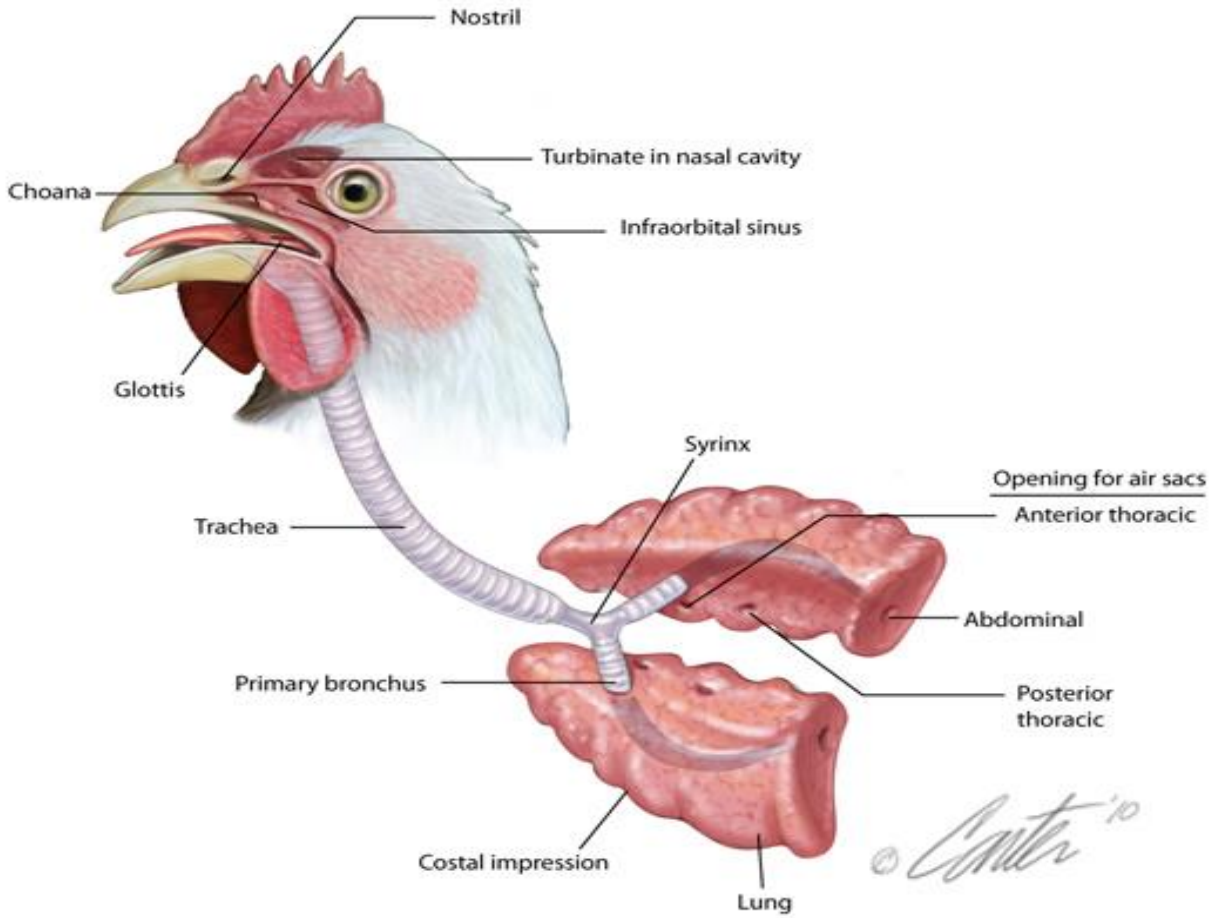
# Respiratory Tract

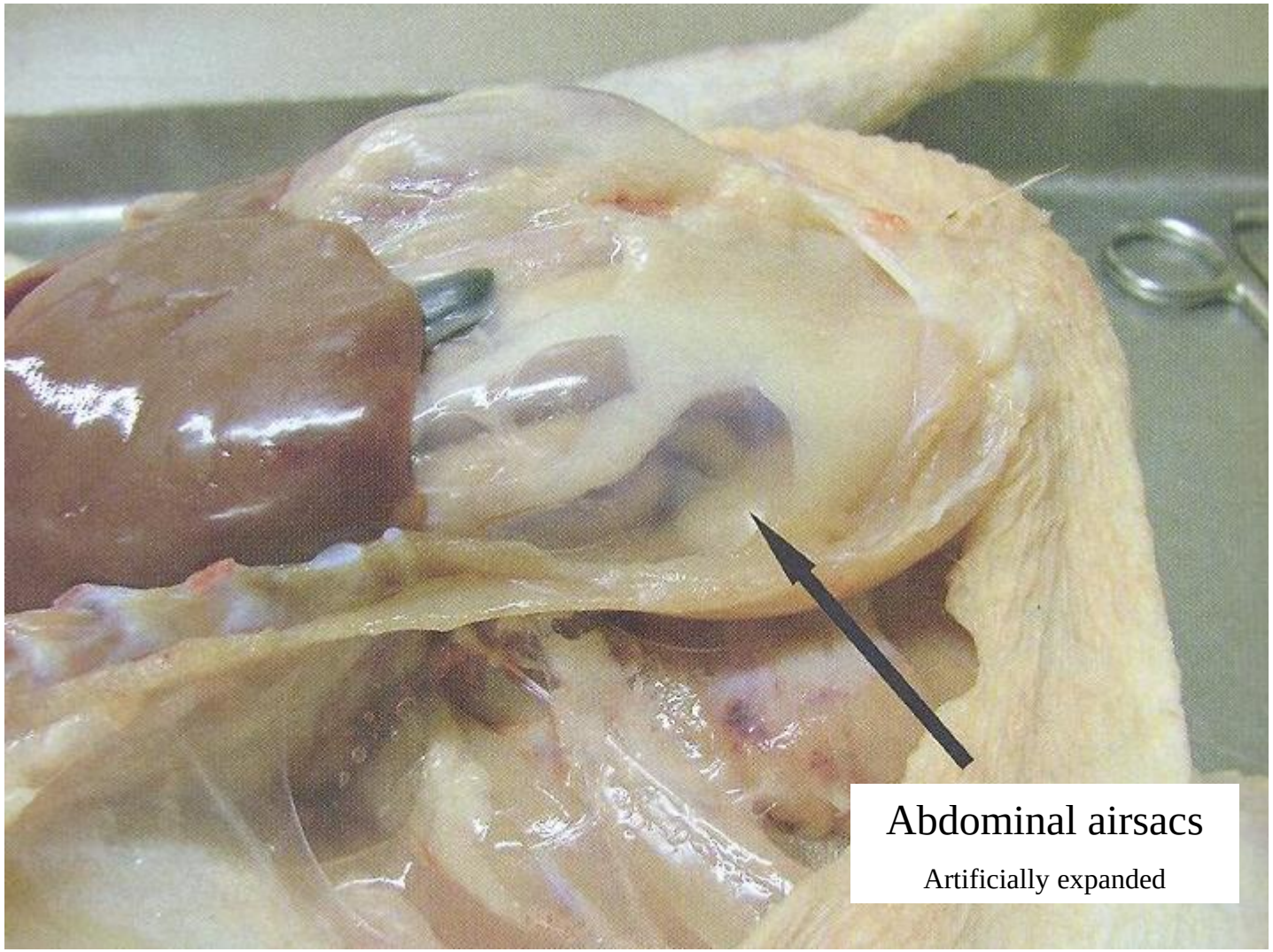
| Parameter | | Amount |
|---|---|---|
| Air sac gases | | (mmHg) |
| $Co_2$ mean partial pressure | Abdominal | 15 |
| | Clavicular | 44 |
| | Thoracic | |
| | Caudal | 24 |
| | Cranial | 42 |
| $O_2$ mean partial pressure | Abdominal | 130 |
| | Clavicular | 84 |
| | Thoracic | |
| | Caudal | 102 |
| | Cranial | 99 |
| Exchange surface area | | 14 $cm^2$/g/body weight |
| Expired gases | | (mmHg) |
| $CO_2$ partial pressure | | 28 |
| $O_2$ partial pressure | | 108 |
| Oxygen uptake | | 24-26 (ml/kg/min) |
| Pulmonary ventilation rate ($V_E$) | | 0.5-0.7 (l/min) |
| Respiratory frequency ($f_R$) | ♂ | 12-21 (breaths/min) |
| | ♀ | 20-37 (breaths/min) |
| Volume of respiratory tract | | (ml) |
| Abdominal sacs, paired | ♂ | 180 |
| | ♀ | 110 |
| Clavicular sac | ♂ | 95 |
| | ♀ | 55 |
| Cervical sacs | ♂ | 30 |
| | ♀ | 20 |
| Lungs, paired | ♂ | 70 |
| | ♀ | 35 |
| Thoracic caudal sacs, paired | ♂ | 30 |
| | ♀ | 24 |
| Thoracic cranial sacs, paired | ♂ | 90 |
| | ♀ | 50 |
| **Total** | ♂ | 500 |
| | ♀ | 300 |

# Anatomy of the avian respiratory system



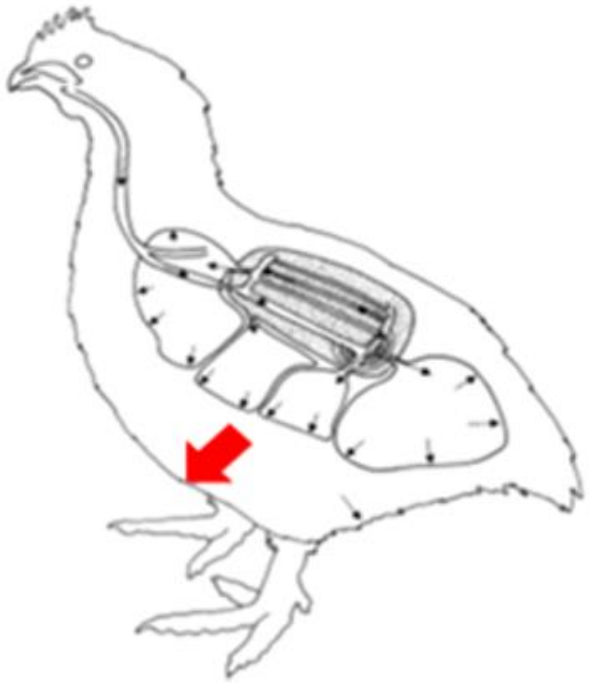


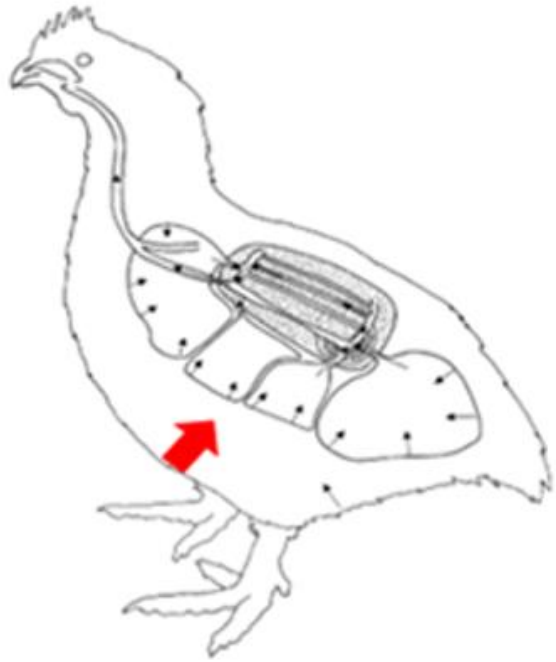

Nostril
Turbinate in nasal cavity
Choana
Infraorbital sinus
Glottis
Syrinx
Opening for air sacs
Anterior thoracic
Trachea
Abdominal
Primary bronchus
Posterior thoracic
Costal impression
Lung

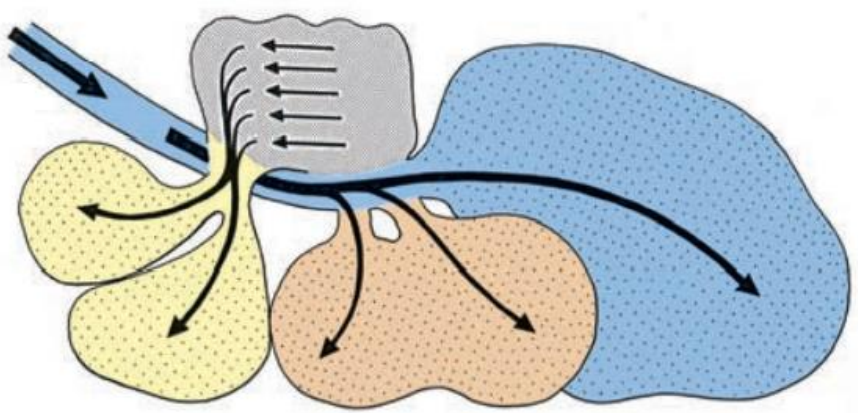


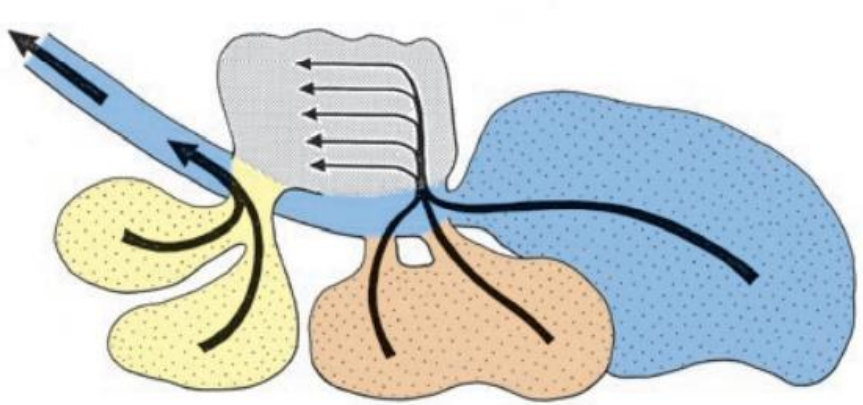
Abdominal airsacs

Artificially expanded



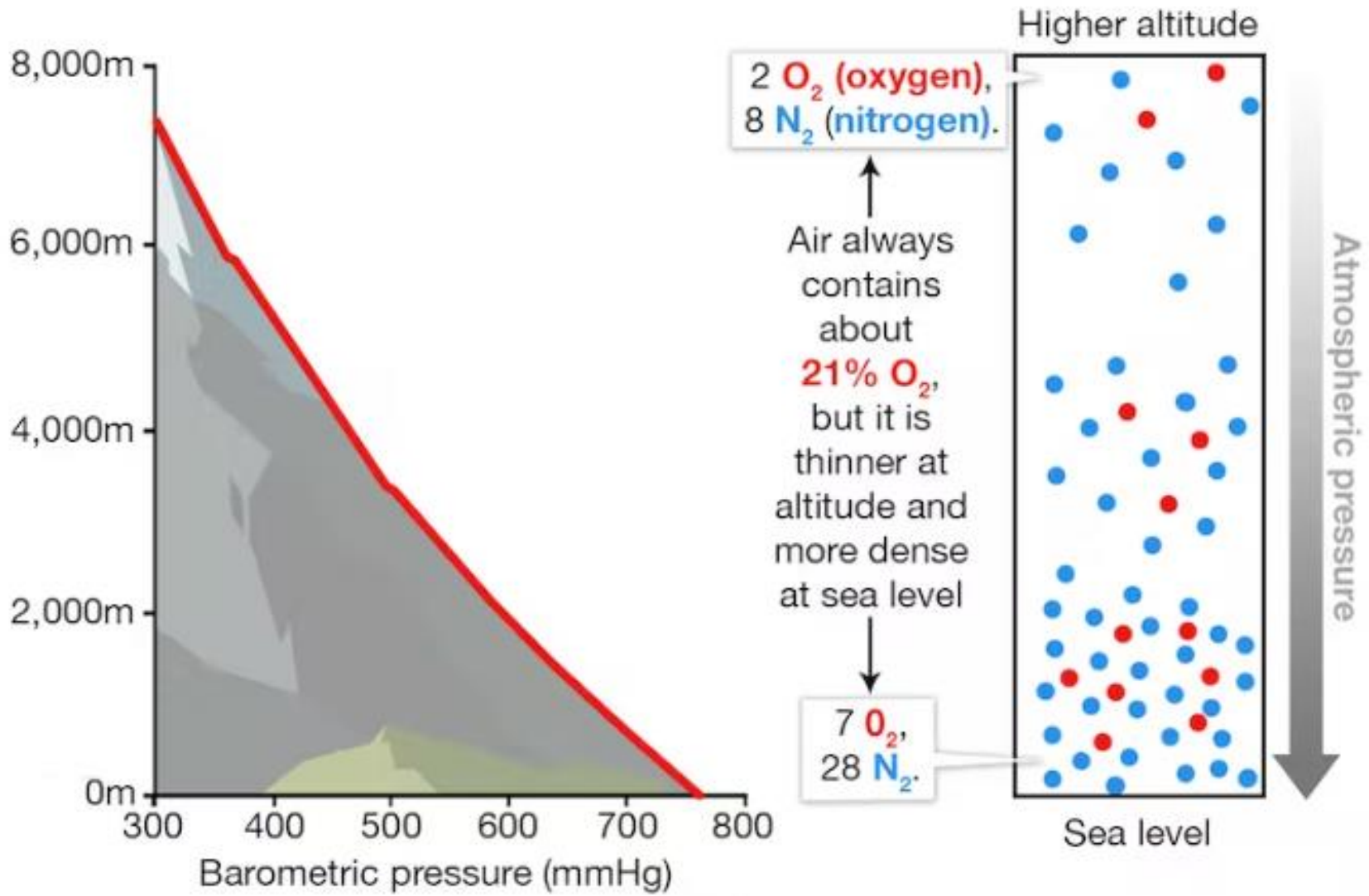






# Factors Influencing Pulmonary Arterial Pressure

1- Increased pulmonary blood flow or cardiac output
   - A- Metabolic rate (growth rate, gain composition 3.1 L/g/pro *vs* 0.82 L/g/fat)
   - B- Hypoxia
     - -Carbon monoxide, Ammonia, dust
     - -Diet
     - -Altitude
2- Organic vascular obstruction
3- Development of mature RBC
4- Increased pulmonary venous pressure


8,000m
6,000m
4,000m
2,000m
0m
300
400
500
600
700
800
Barometric pressure (mmHg)
Higher altitude
2 O2 (oxygen),
8 N2 (nitrogen).
Air always contains about 21% O2, but it is thinner at altitude and more dense at sea level
7 O2,
28 N2.
Atmospheric pressure
Sea level

# Factors Influencing Pulmonary Arterial Pressure

- 1- Increased pulmonary blood flow or cardiac output
  - A- Metabolic rate (growth rate, gain composition 3.1 L/g/pro *vs* 0.82 L/g/fat)
  - B- Hypoxia
    - -Carbon monoxide, Ammonia, dust
    - -Diet
    - -Altitude
- 2- Organic vascular obstruction
  - A- Blockage of capillaries
  - B- Megalocytosis
    - -Young birds
  - C- Polycythemia
    - - Diet sodium
    - - Erythrocyte flexibility
- 3- Development of mature RBC
  - Several hormones
  - -Erythropoietin
  - -Corticosterone
  - -Triiodothyronine
- 4- Increased pulmonary venous pressure (Rarely seen in birds)

# Molecular mechanisms of Pulmonary Arterial Pressure

1- Hypoxia → Imbalance of vasoactive factors

A- Increasing pulmonary vascular resistance (hypoxic pulmonary vasoconstriction)

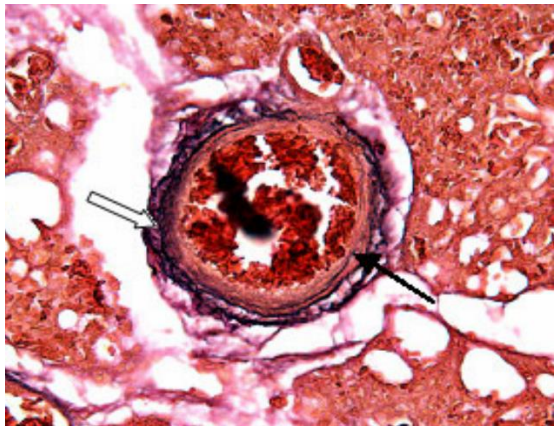
B- Reducing systemic vascular resistance (hypoxic systemic vasodilation)

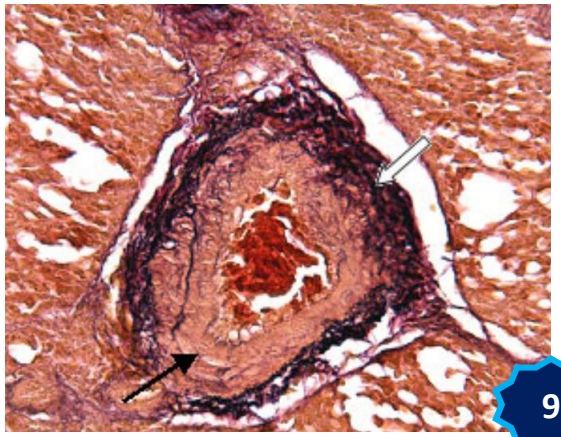
ET-1 ↑ (strongest vasoconstrictor)
- ETA ↑ (intracellular $Ca^{++}$)
- ETB ↑ (smooth muscle, vasoconstriction)
- ETB ↓ (endothelial cells, vasodilation by releasing NO)

2- Morphological changes

A- PVSM proliferation (± apoptosis & proliferation)

Hypoxia signal





# Molecular mechanisms of Pulmonary Arterial Pressure

1- Hypoxia → Imbalance of vasoactive factors

A- Increasing pulmonary vascular resistance (hypoxic pulmonary vasoconstriction)

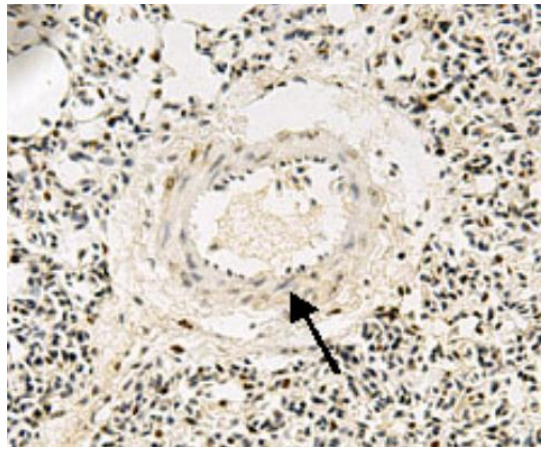
B- Reducing systemic vascular resistance (hypoxic systemic vasodilation)

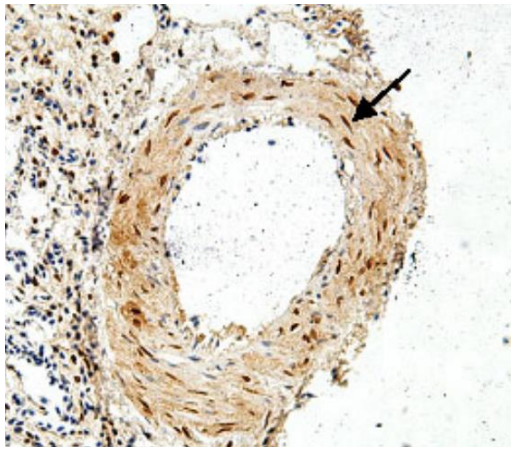
ET-1 ↑ (strongest vasoconstrictor)
- ETA ↑ (intracellular $Ca^{++}$)
- ETB ↑ (smooth muscle, vasoconstriction)
- ETB ↓ (endothelial cells, vasodilation by releasing NO)

2- Morphological changes ← Hypoxia signal

A- PVSM proliferation (± apoptosis & proliferation)

B- Pulmonary arterial medial thickening (vessel lumen will be narrowed)





# Molecular mechanisms of Pulmonary Arterial Pressure

1- Hypoxia → (Imbalance of vasoactive factors)
- A- Increasing pulmonary vascular resistance (hypoxic pulmonary vasoconstriction)
- B- Reducing systemic vascular resistance (hypoxic systemic vasodilation)

Imbalance of vasoactive factors:
- ET-1 ↑ (strongest vasoconstrictor)
  - ETA ↑ (intracellular $Ca^{++}$)
  - ETB ↑ (smooth muscle, vasoconstriction)
  - ETB ↓ (endothelial cells, vasodilation by releasing NO)

2- Morphological changes
- A- PVSM proliferation (± apoptosis & proliferation)
- B- Pulmonary arterial medial thickening (vessel lumen will be narrowed)
- C- PA remodeling (RMT/RWA)
- D- Thromboembolism
- E- EC swelling
- F- Inflammation → Cytokines→↑IRG1→ VSM remodeling
- G- Thick LV wall, thick LV wall
- H- Gene expressions (Regulating gene: HIF-1)
  - EPO
  - VEGF
  - GE

Hypoxia signal

# Molecular mechanisms of Pulmonary Arterial Pressure

1- Hypoxia → (Imbalance of vasoactive factors)

A- Increasing pulmonary vascular resistance (hypoxic pulmonary vasoconstriction)

These molecules have been increasingly recognized as critical factors and potential therapeutic targets in the treatment of PAH.

Sufang *et al.*, 2021 Poultry Science 100:100877

2- Morphological changes

Hypoxia signal

B- Pulmonary arterial medial thickening (vessel lumen will be narrowed)

C- PA remodeling (RMT/RWA)

D- Thromboembolism

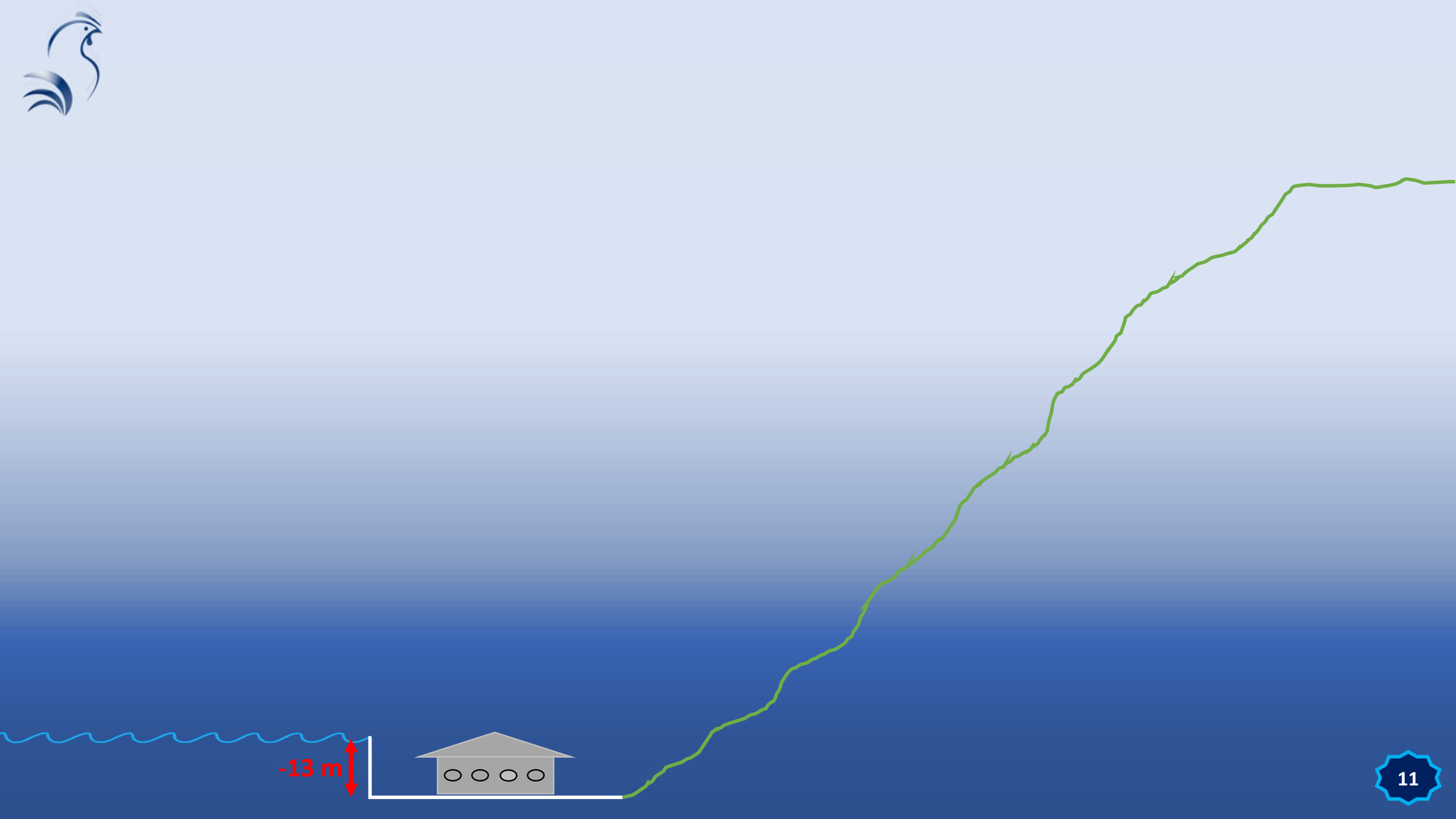
E- EC swelling

F- Inflammation → Cytokines→↑IRG1→ VSM remodeling

G- Thick LV wall, thick LV wall

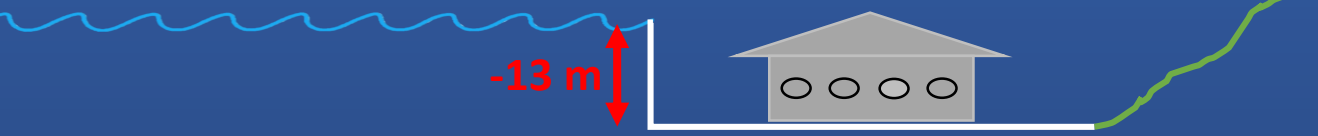
H- Gene expressions → (Regulating gene: HIF-1)
- EPO
- VEGF
- GE

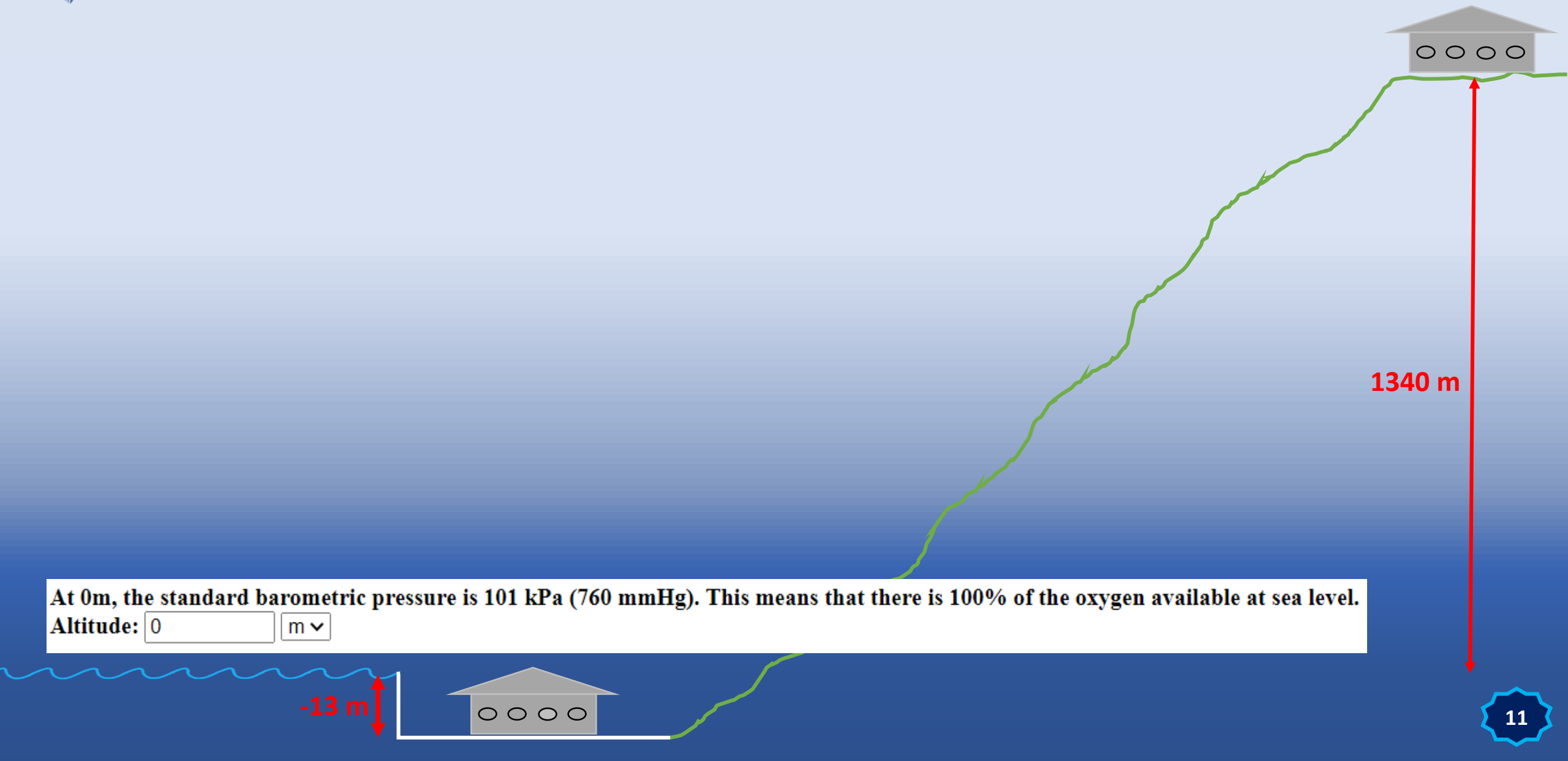
# Experimental Design


-13 m

**At 0m, the standard barometric pressure is 101 kPa (760 mmHg). This means that there is 100% of the oxygen available at sea level.**

**Altitude:** 0 m






**At 0m, the standard barometric pressure is 101 kPa (760 mmHg). This means that there is 100% of the oxygen available at sea level.**

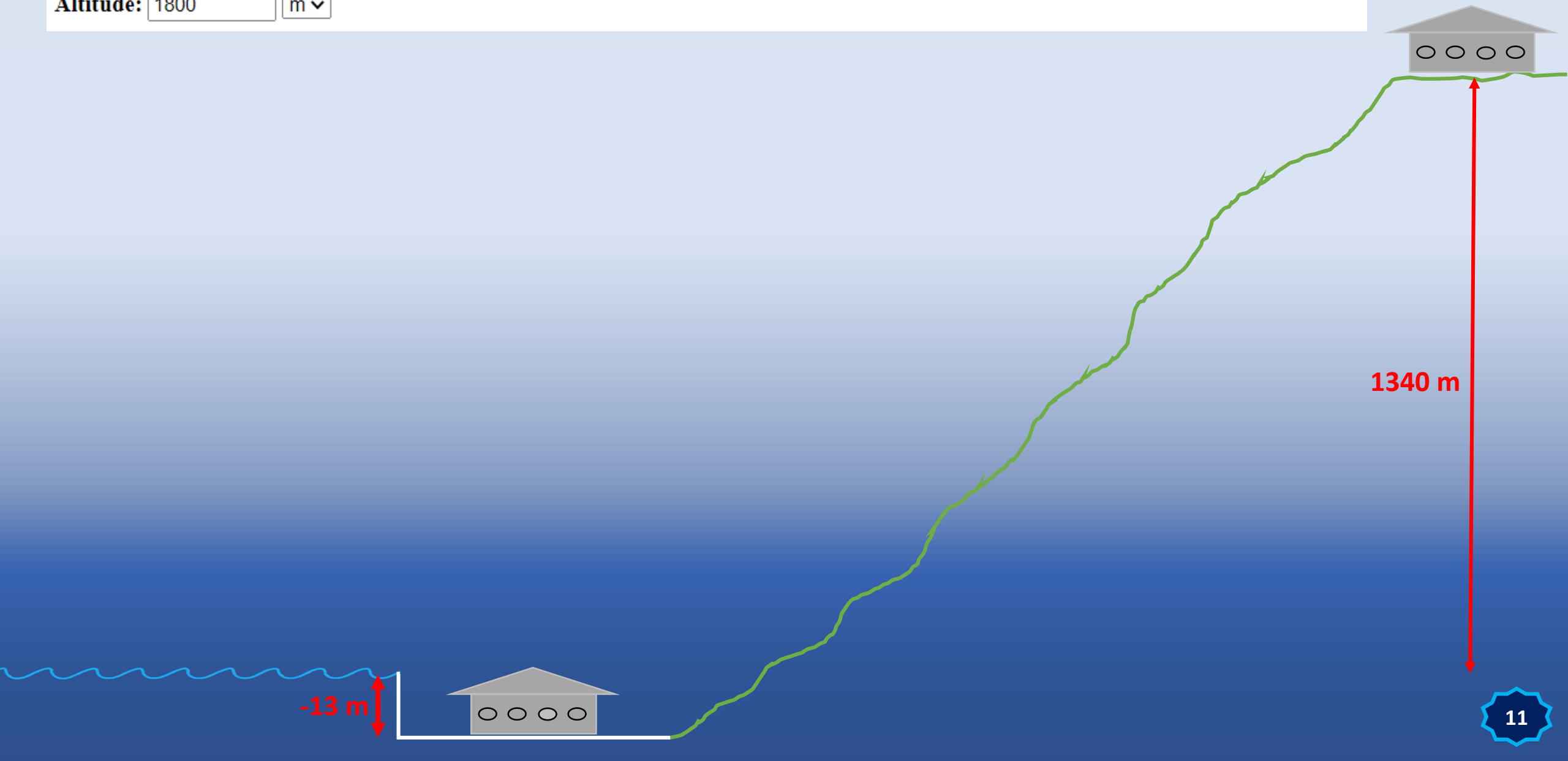
**Altitude:** 0 m

**At 1340m, the standard barometric pressure is 87 kPa (653 mmHg). This means that there is 86% of the oxygen available at sea level.**

**Altitude:** 1340 m

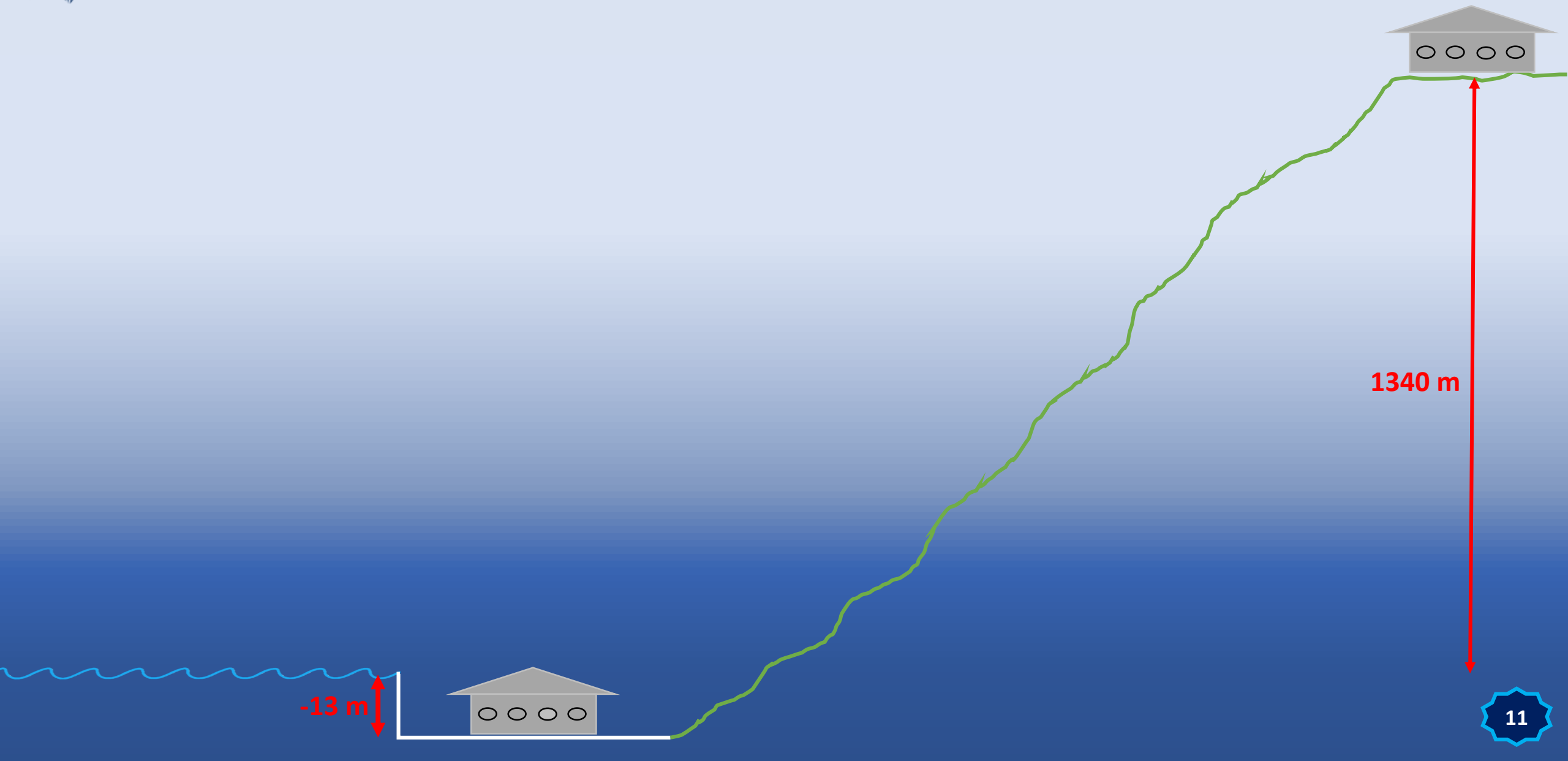
**At 1800m, the standard barometric pressure is 82 kPa (619 mmHg). This means that there is 81% of the oxygen available at sea level.**

**Altitude:** 1800 m

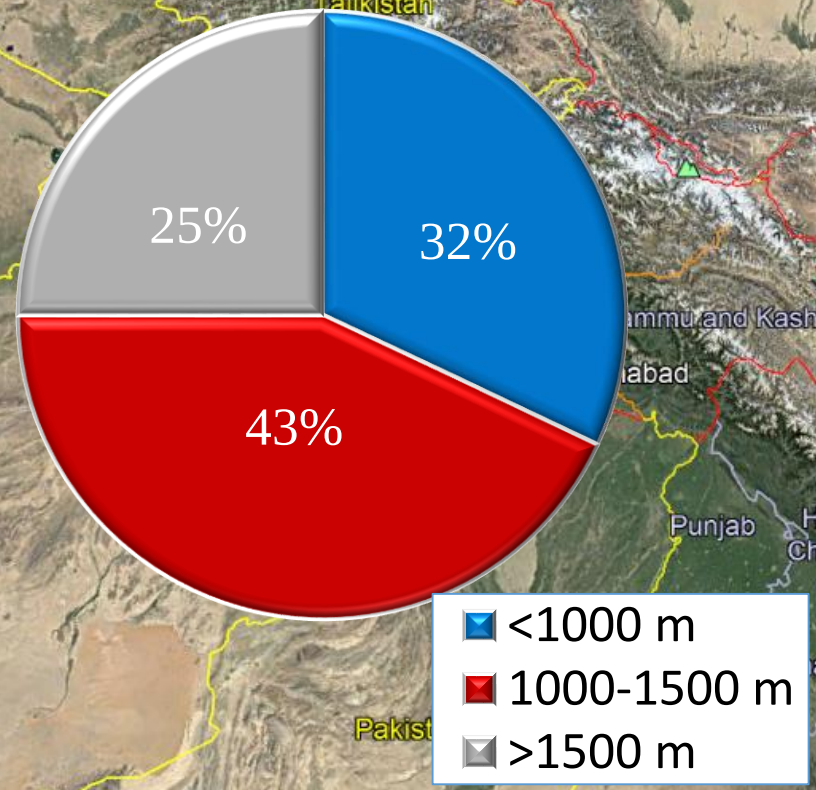


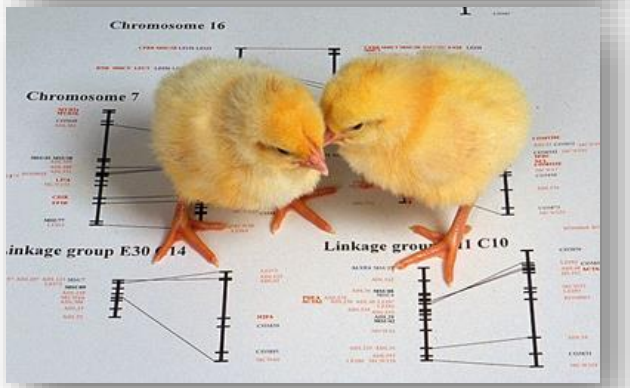
**At 2000m, the standard barometric pressure is 81 kPa (604 mmHg). This means that there is 80% of the oxygen available at sea level.**

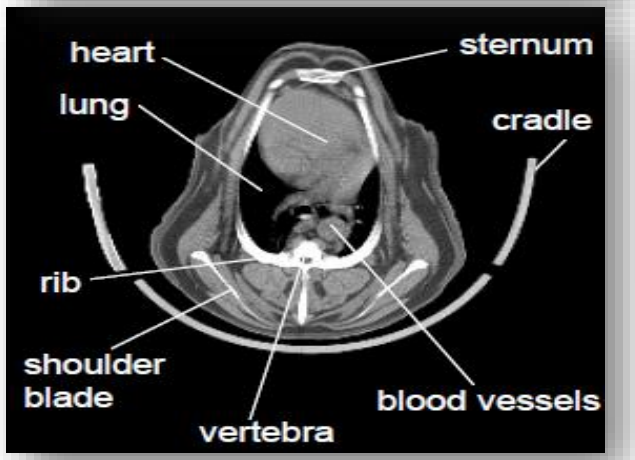
**Altitude:** 2000 m



## Broiler production at different altitude



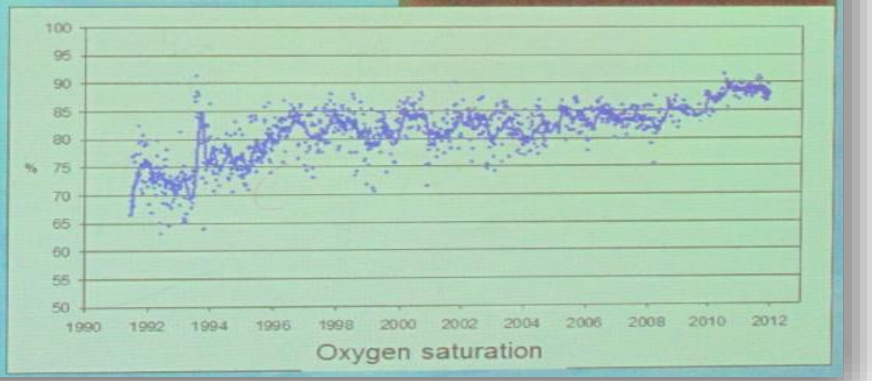


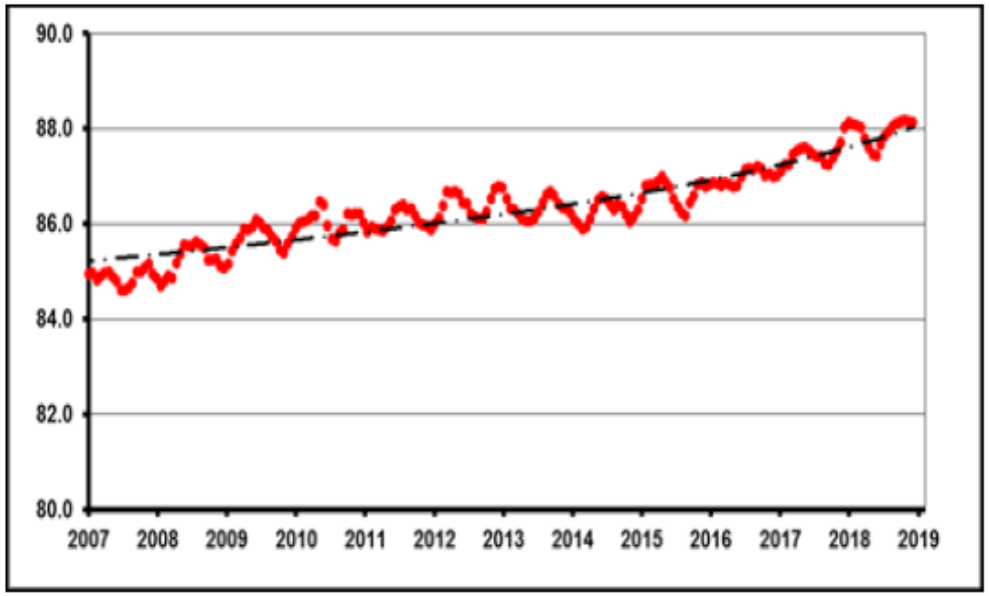




Aviagen

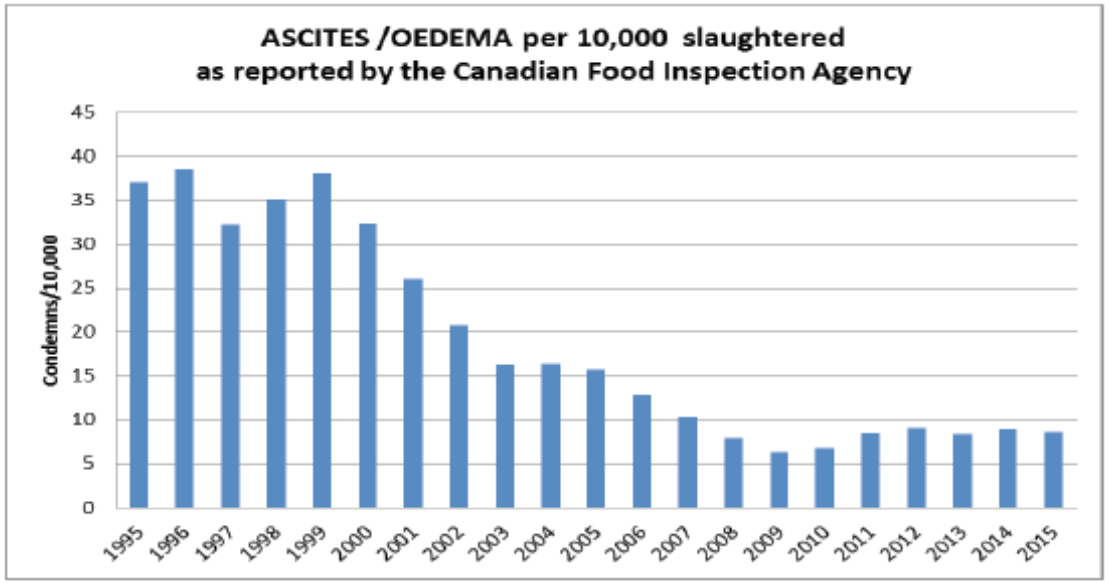
## Heart and lung function

- Oximeter used to measure cardiovascular fitness
- Sustained response in oxygen saturation






*Trend graph of heart and lung fitness improvements of Ross 308 pedigree birds (2007-2019) using Oximeter.*

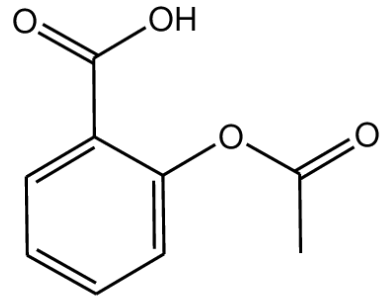



*Ascites related condemnation rates in broilers per 10,000 (1995-2015; Canadian Food Inspection Agency).*

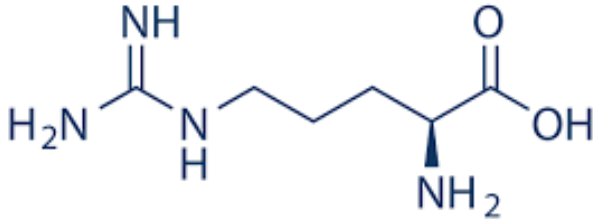
# Combination dosage

(mg/Kg BW)

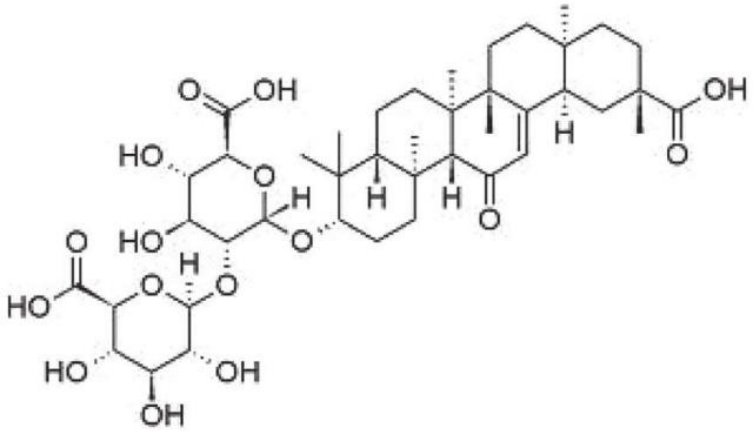
- 1.8 mg, Acetylsalicylic acid



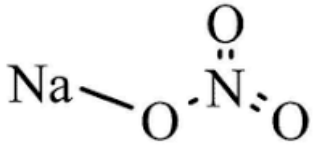
- 36.7 mg, L-arginine



- 7.3 mg, Glycyrrhizin

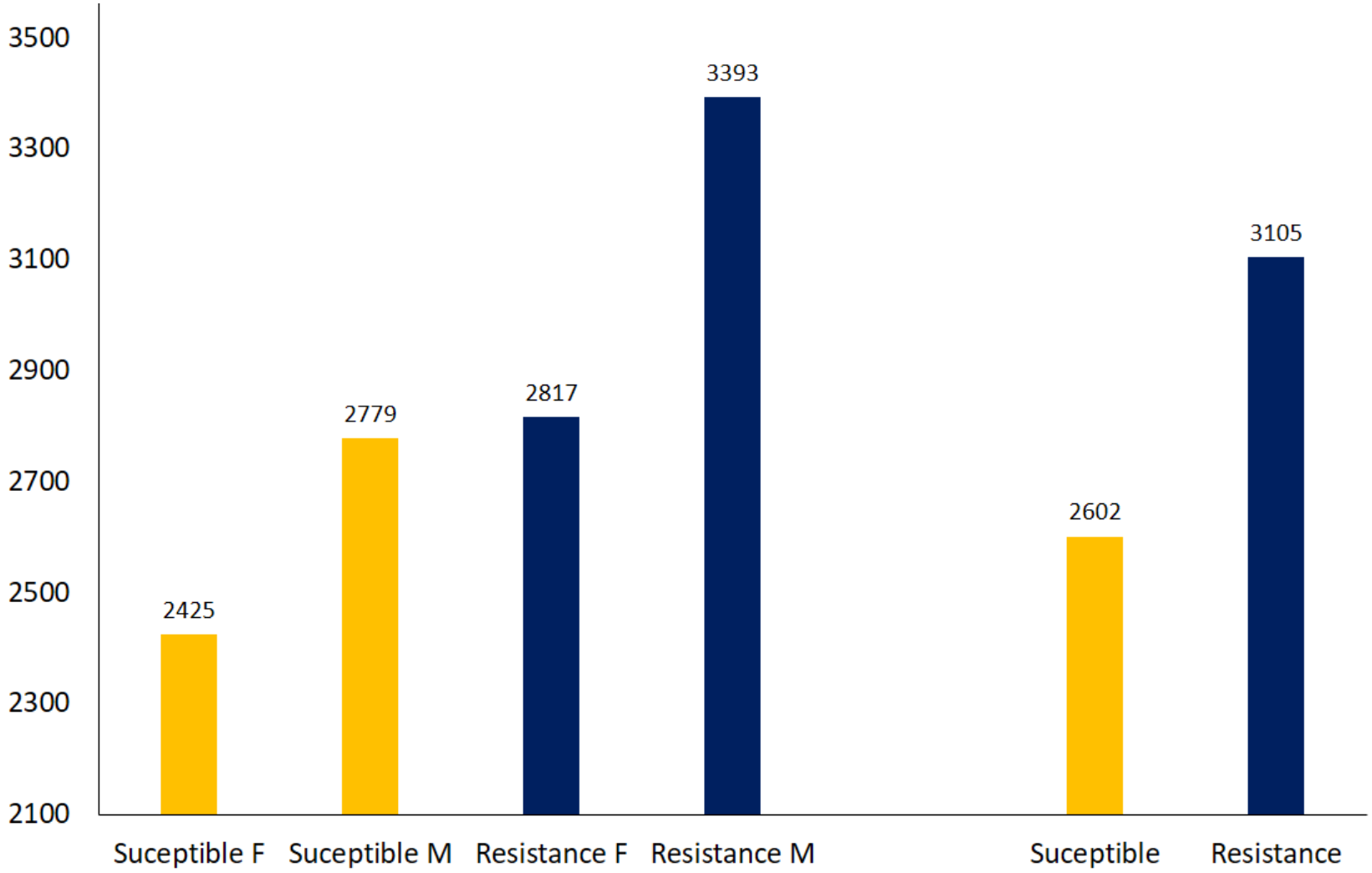


- 46, Sodium Nitrate



# Live Body Weight (g)

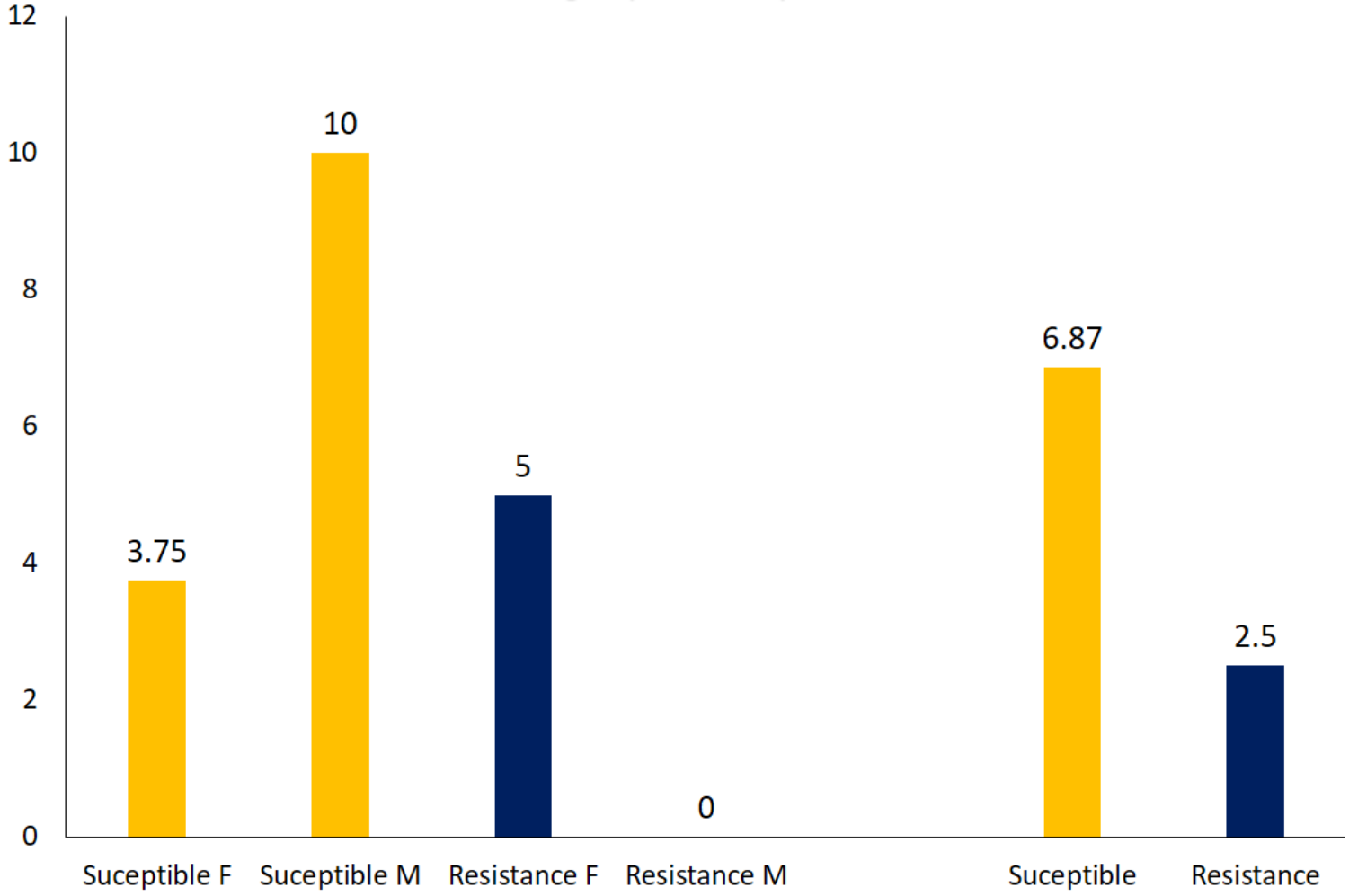
Control groups at 42 d




Strain P<0.0001
Sex P<0.0001

# Total Mortality (%)

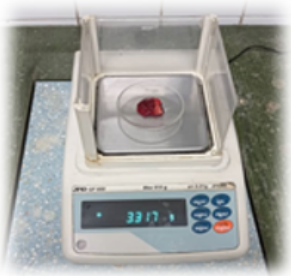
Control groups from day 1 to 42

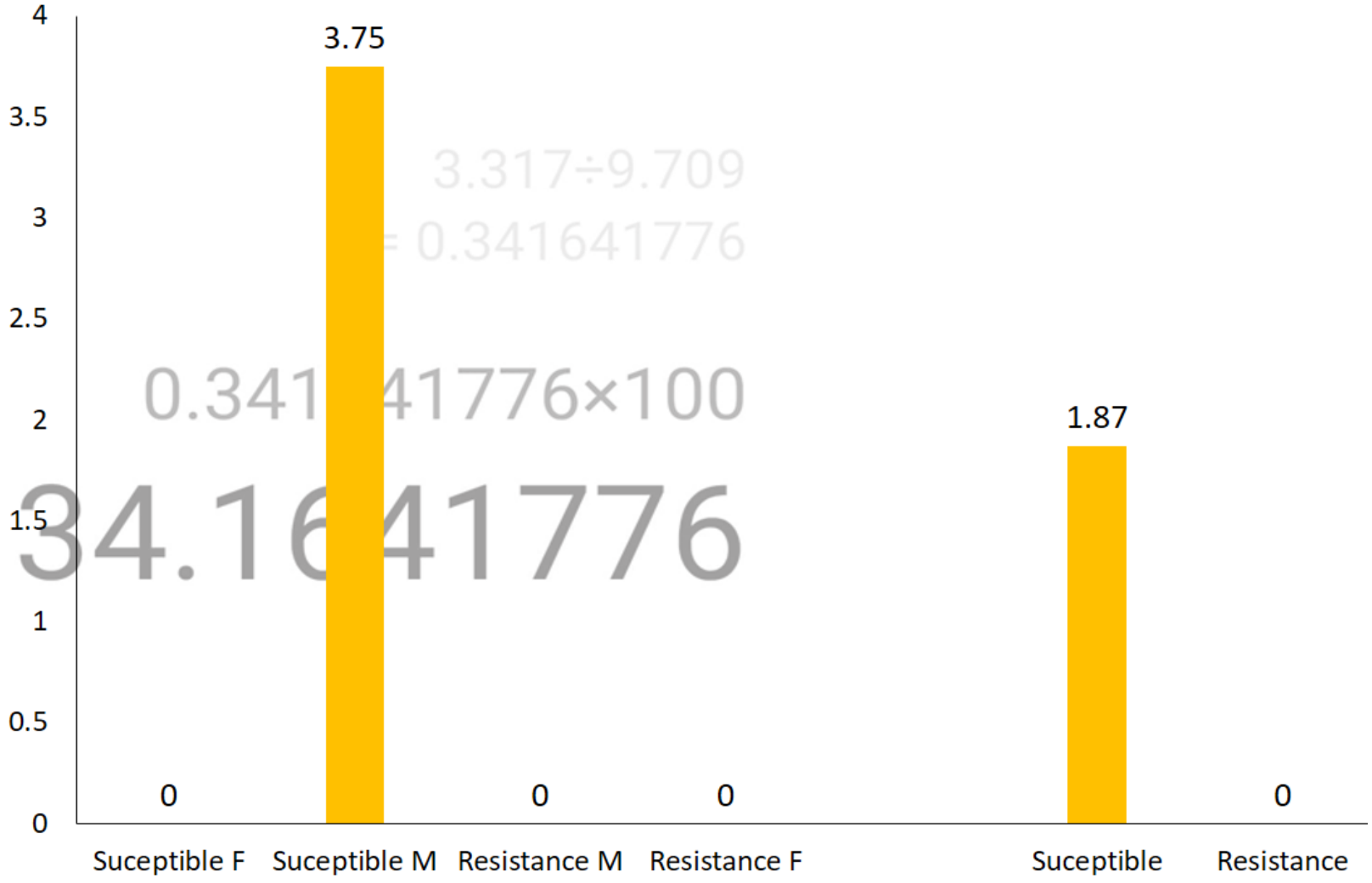



Strain P<0.32
Sex P<0.26

# Ascites Mortality (%)

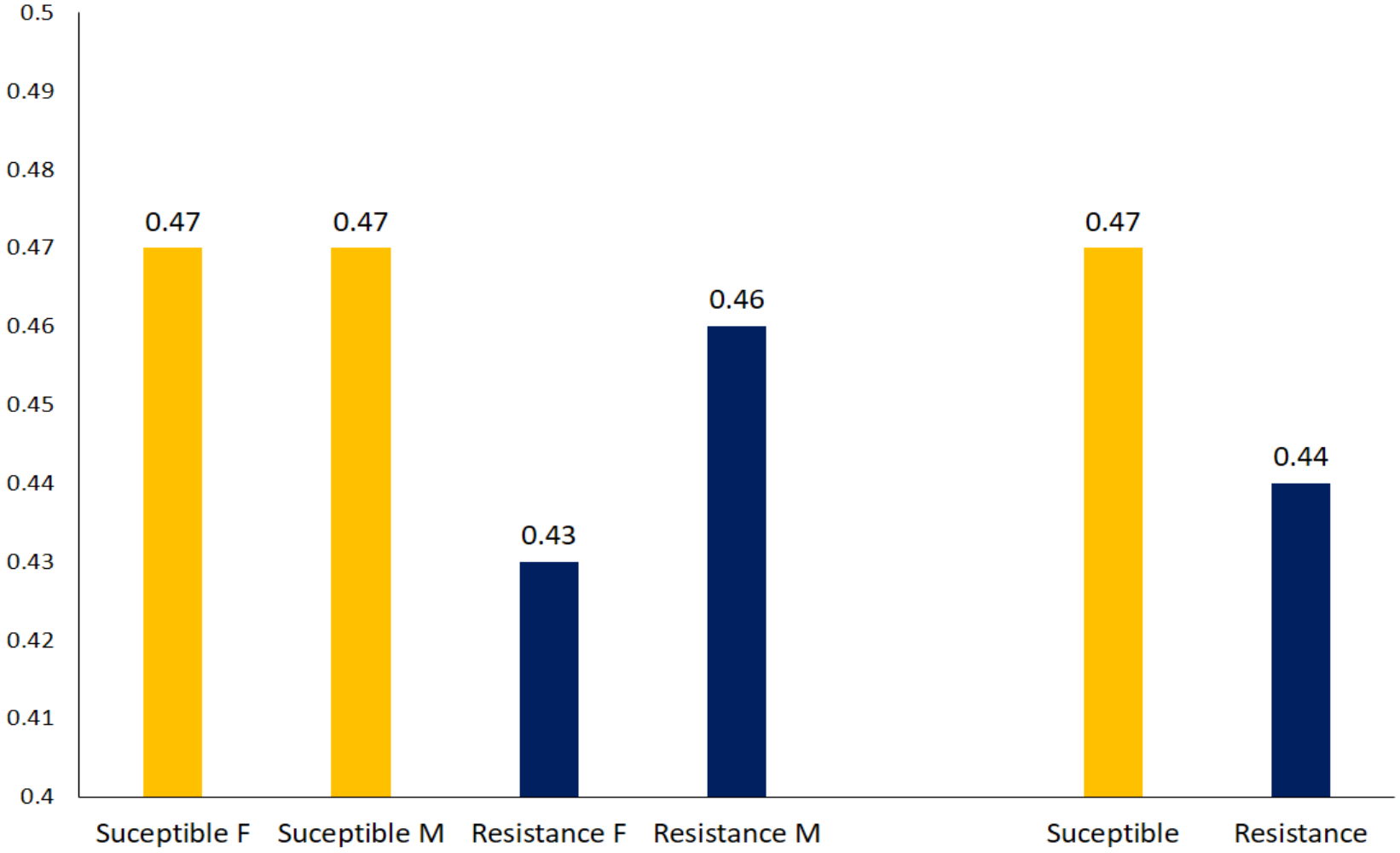
Control groups from day 1 to 42





# Heart Fractional weight

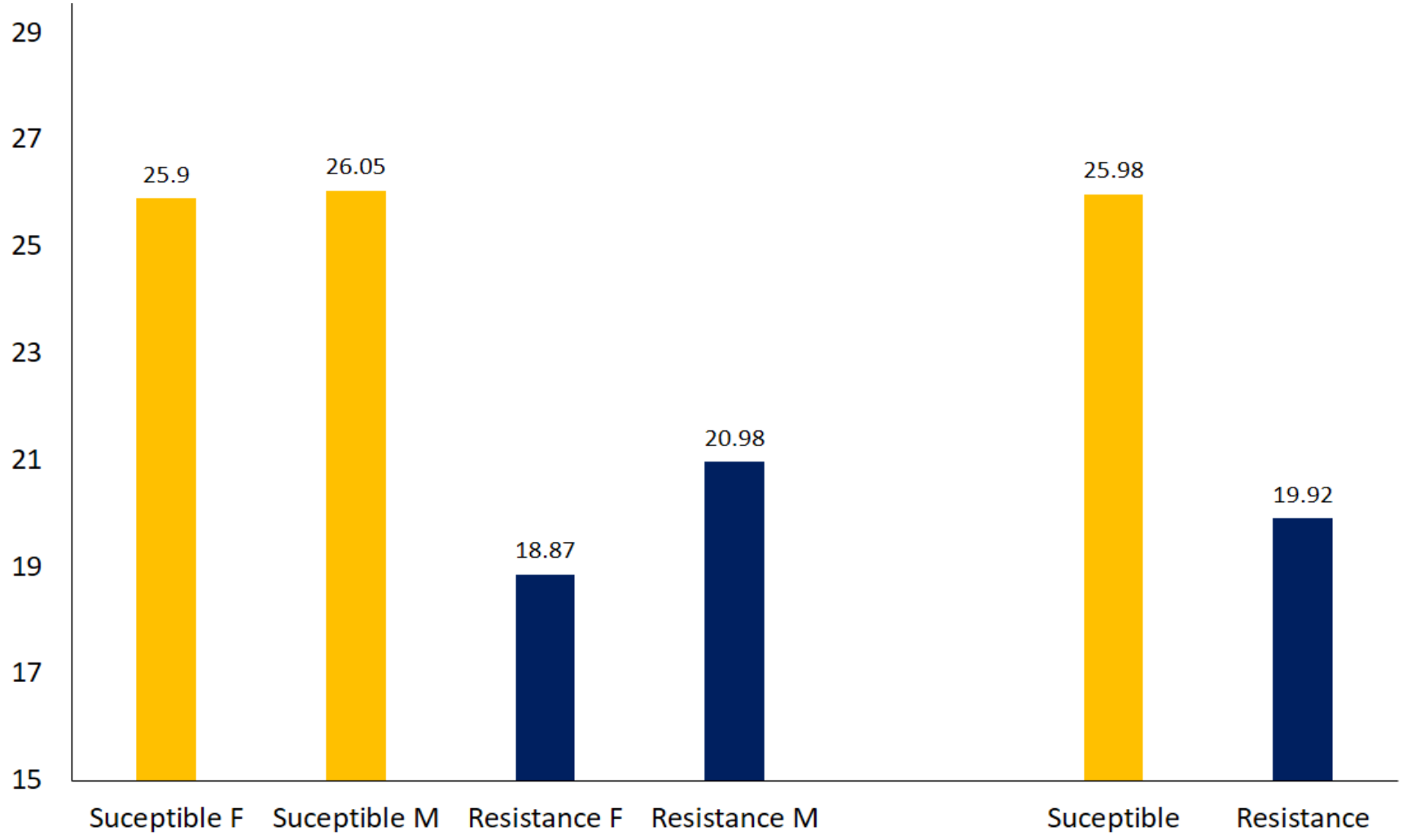
Control groups at 42 d




Strain P<0.3
Sex P<0.9
Strain × Sex P<0.53

# Right Ventricle/Total Ventricle

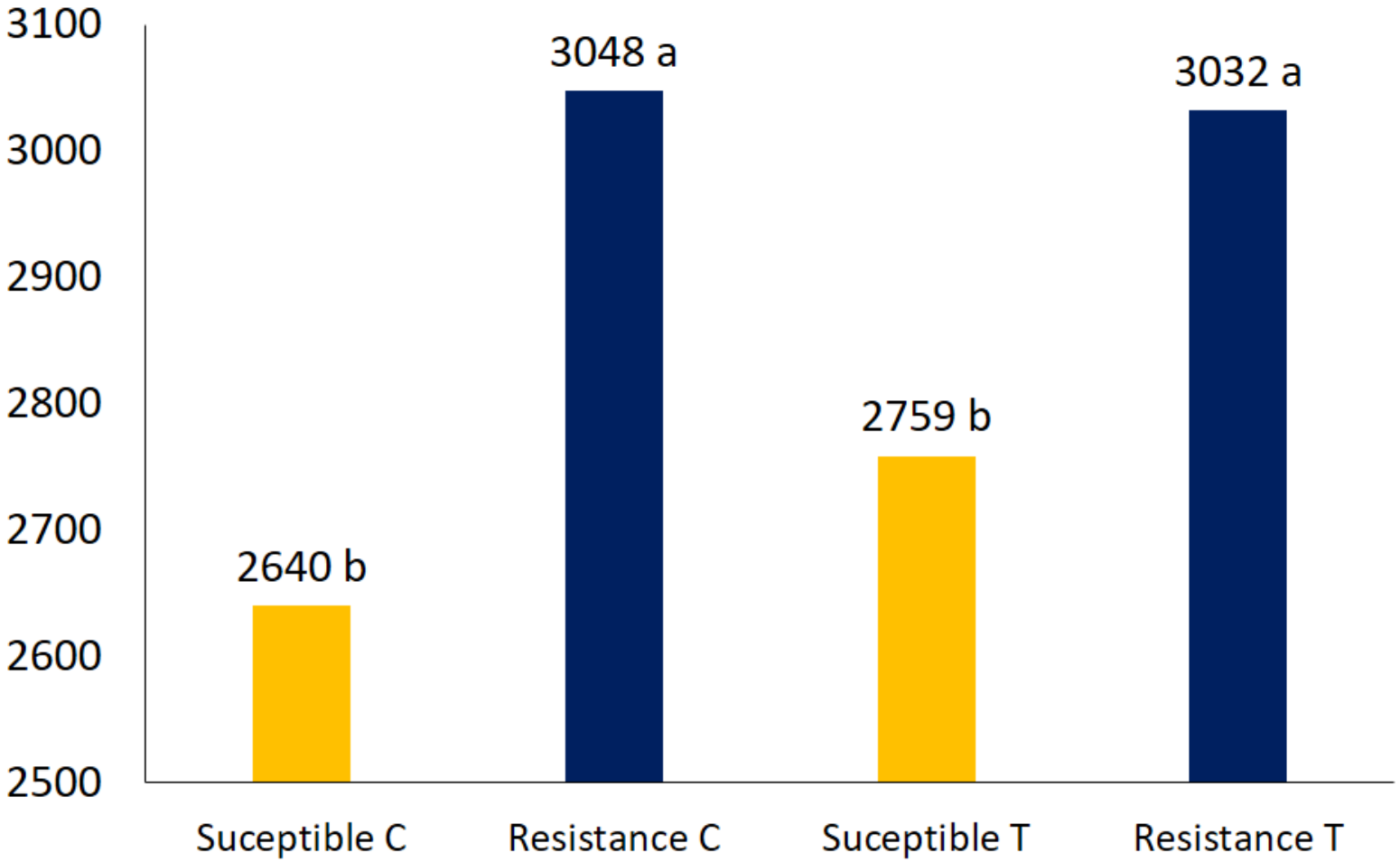
Control groups at 42 d




Strain P<0.0004
Sex P<0.66

# Live Body Weight (g)

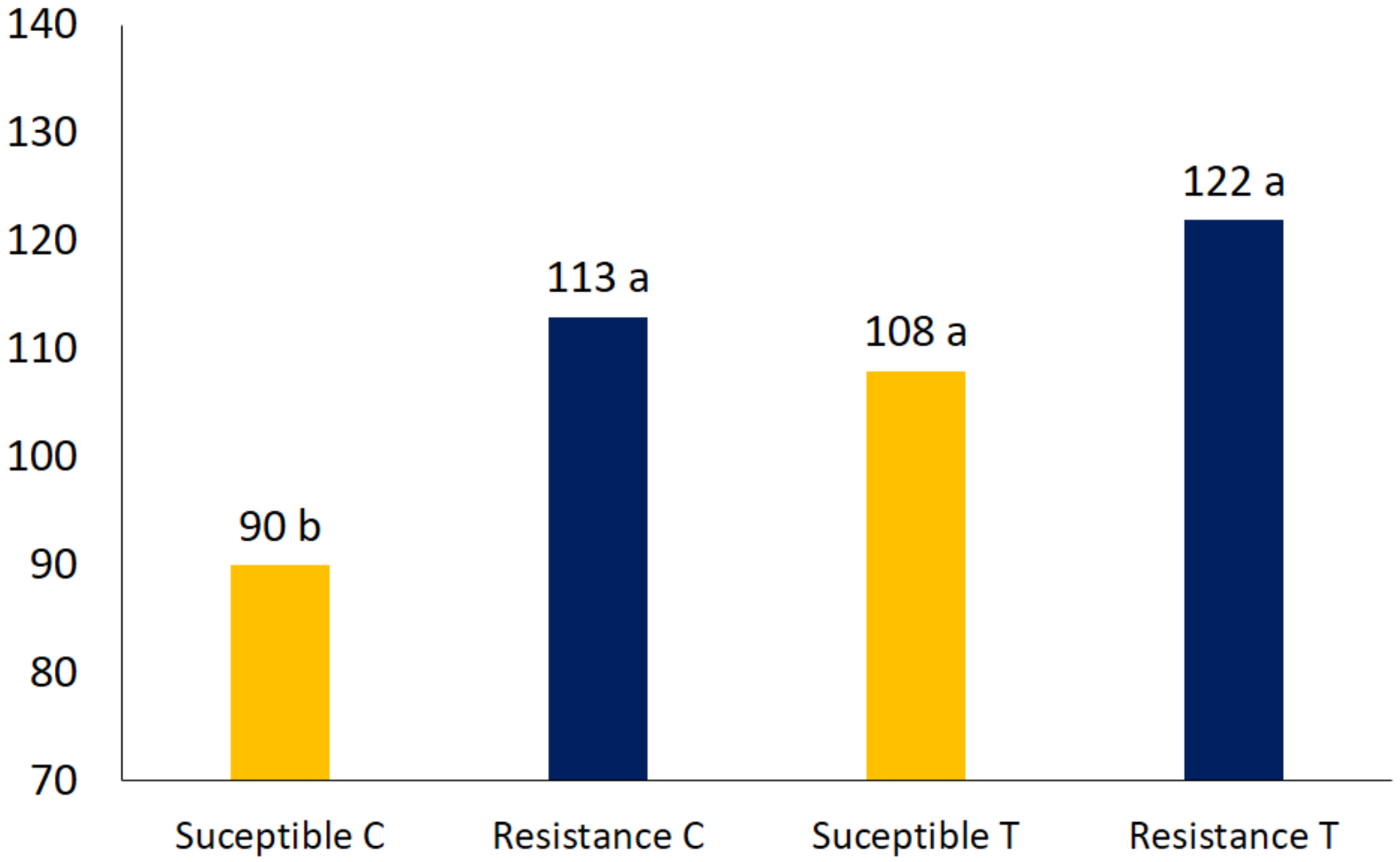
Control & Treated groups at 42 d




Treatment P<0.0001

# Average Daily Body Weight Gain (g)

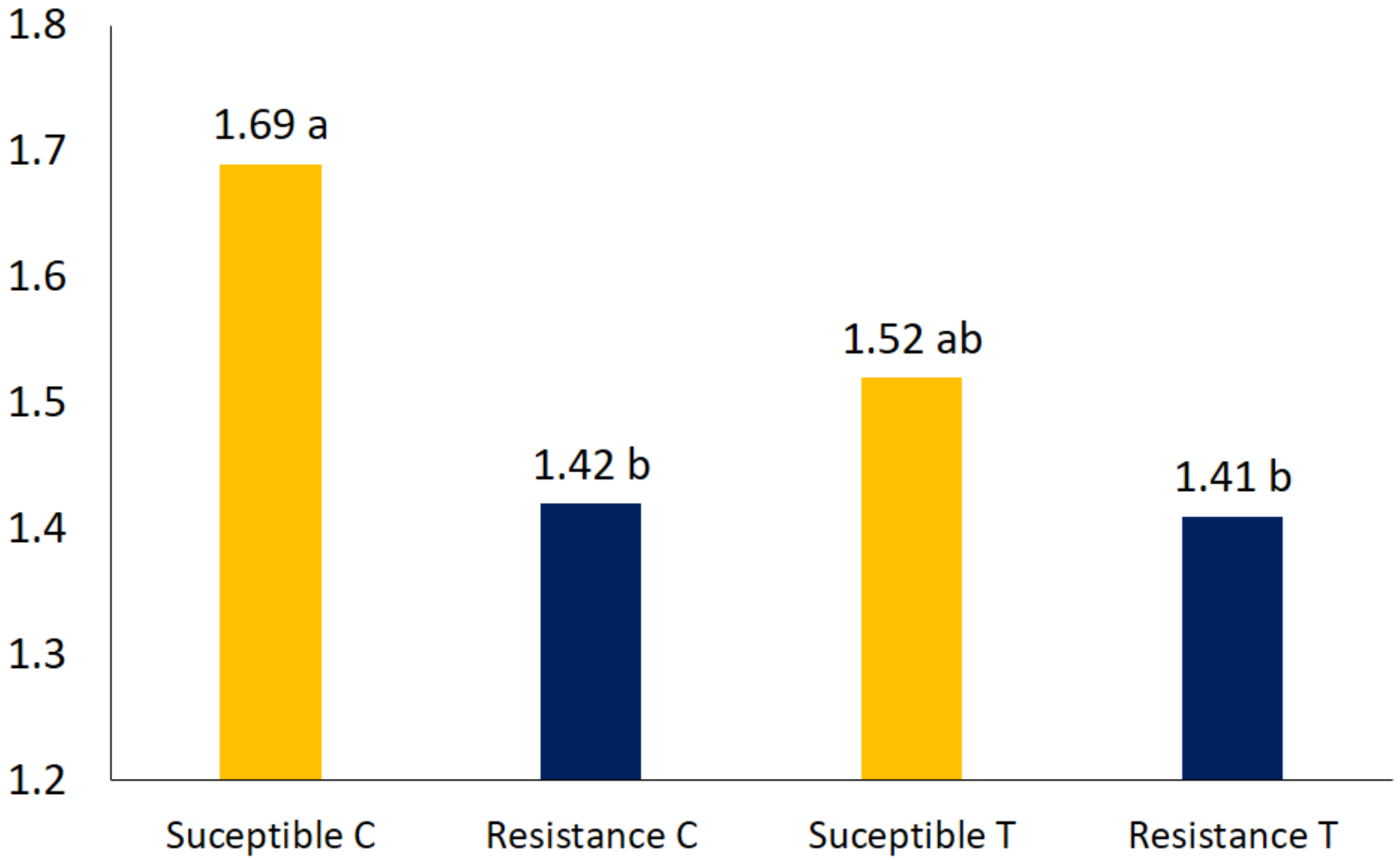
Control & Treated groups (28 to 42 d)




Treatment P<0.0001

# Feed Conversion Ratio

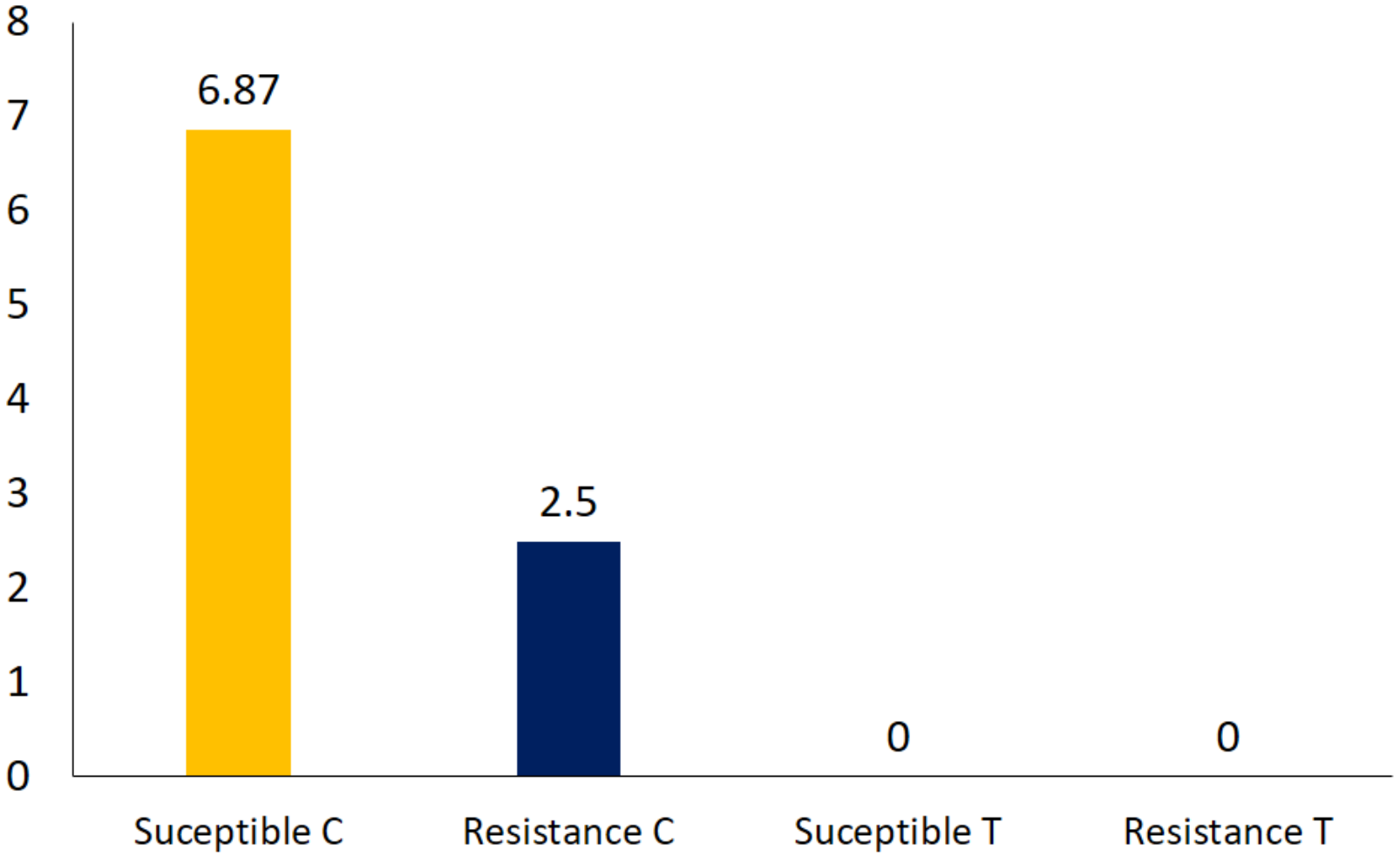
Control & Treated groups




Treatment P<0.0015

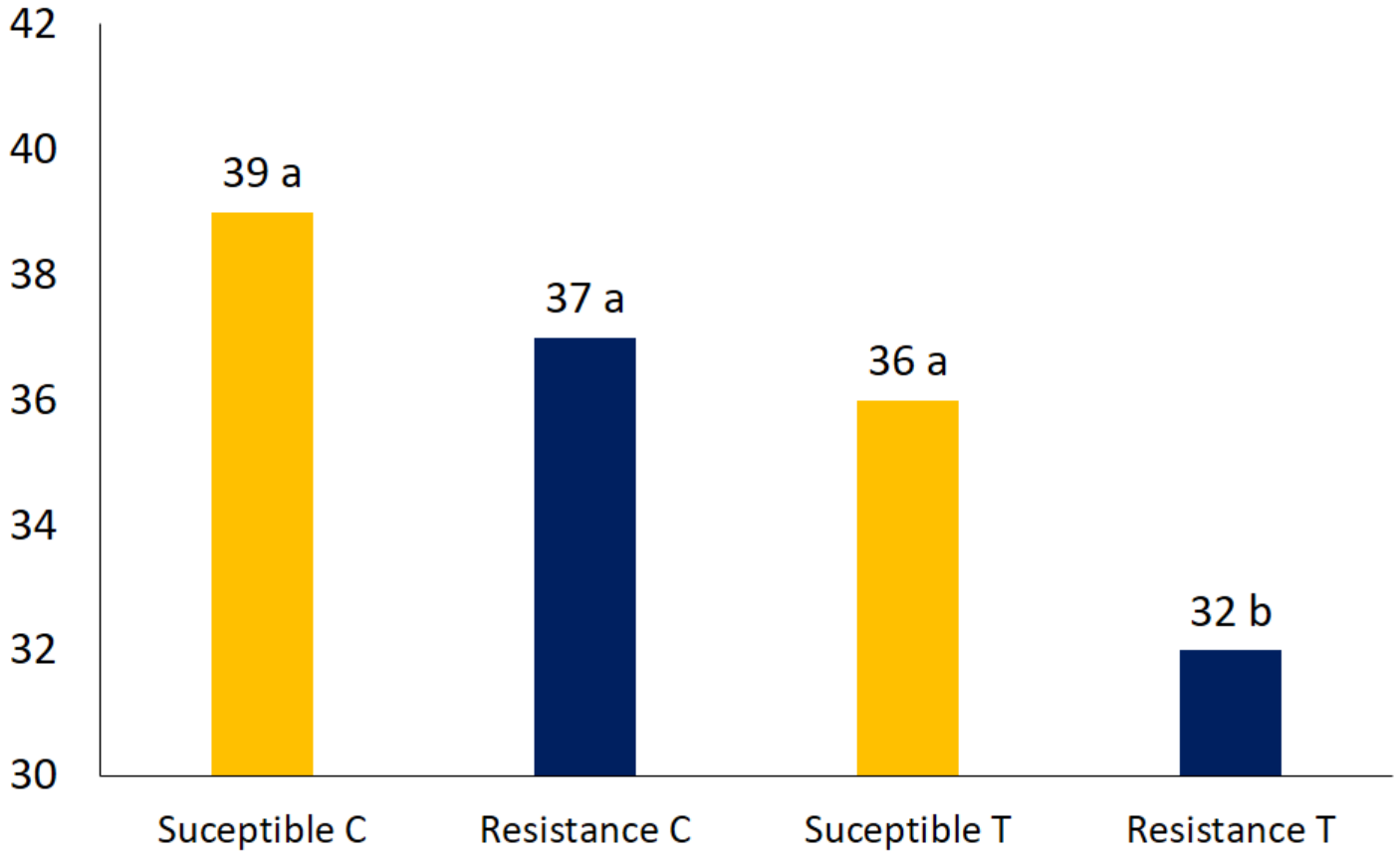
# Mortality (%)

Control & Treated groups



# Hematocrit

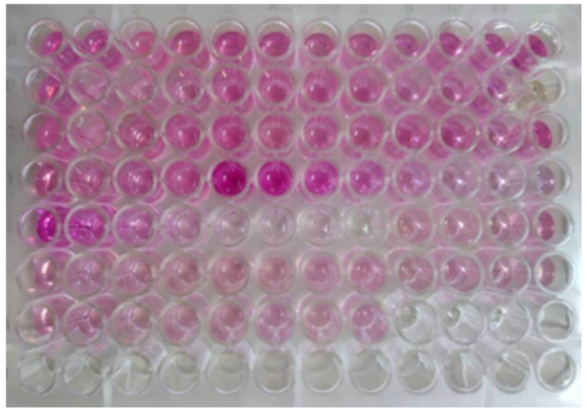
## Control & Treated groups at 42 d

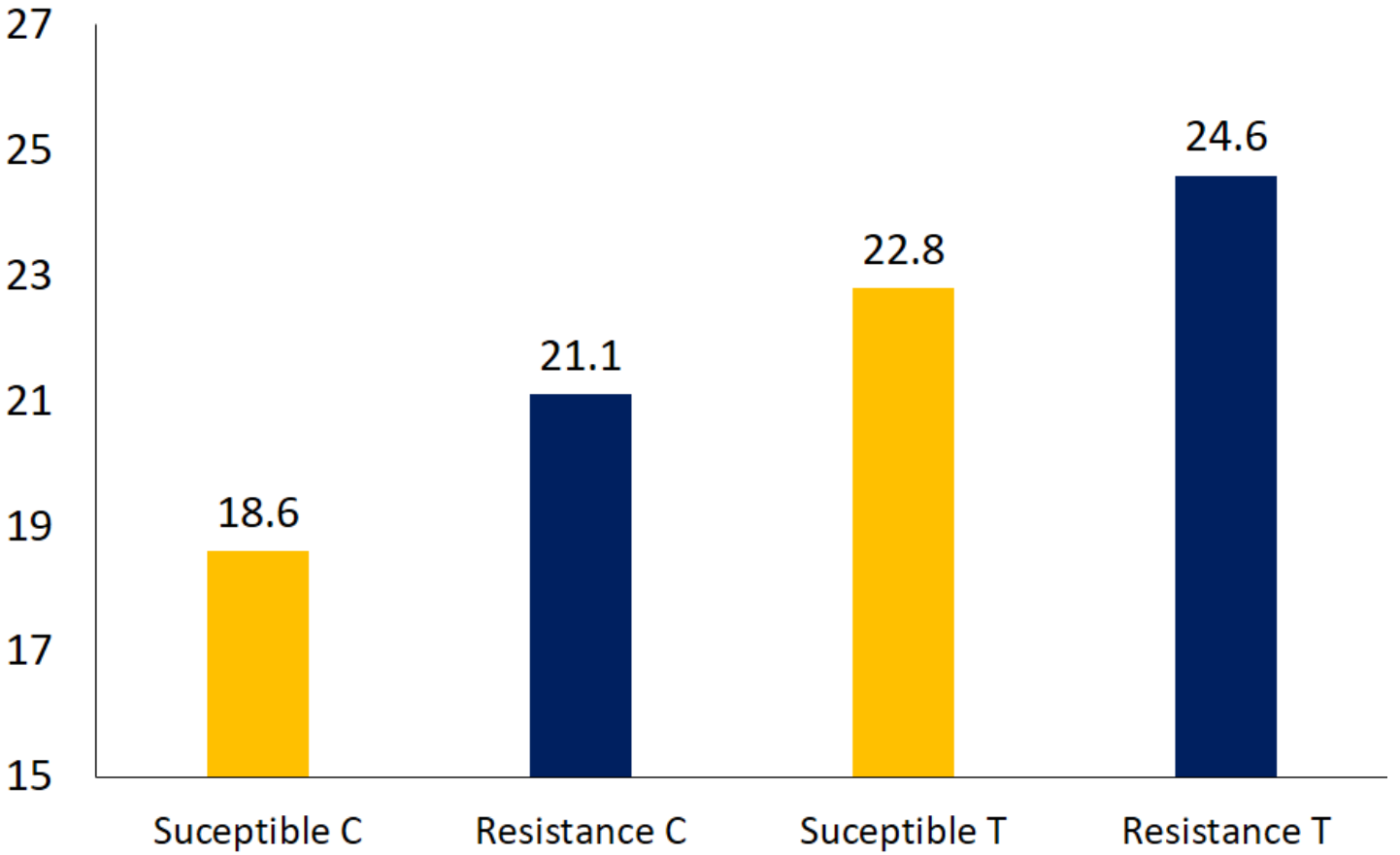




Treatment P<0.0002

# Plasma Total Nitrite Concentration *(mm/dL)*

Control & Treated groups at 42 d






Treatment P<0.15

8th International Veterinary Poultry Congress