THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Cells to Systems Lecture 1: Introduction Video 1

VETS30015 / VETS90121

Dr Laura Dooley
Senior Lecturer

laura.dooley@unimelb.edu.au

Cells to Systems: the big picture

This unit introduces the disciplines of:

- anatomy
- physiology
- pathology
- pharmacology

These provide the foundation for all your veterinary bioscience studies across DVM1 and DVM2

Cells to Systems: Subject ILOs

1. Explain how the structural and functional organisation of the cells, tissues, organs and body systems enable maintenance of homeostasis

2. Communicate anatomical and microscopic features of animal tissues using scientific terminology

3. Explain how homeostasis is maintained through normal hormonal, electrical and pharmacological communication

4.Describe the major components of the immune system and the clinical manifestations of an activated immune response

5. Apply the principles of common infectious and non-infectious pathological processes to explain the clinical features of infection and disease

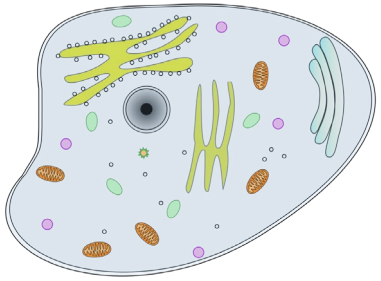
6. Work collaboratively, communicate effectively, and apply an understanding of cellular and organ structure and function in order to analyse and interpret clinical problems in animals

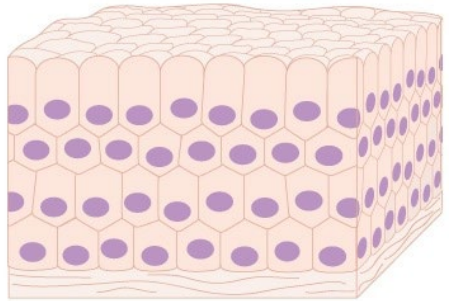
THE UNIVERSITY OF MELBOURNE

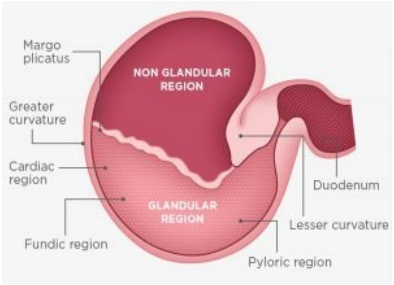
Faculty of Veterinary and Agricultural Sciences

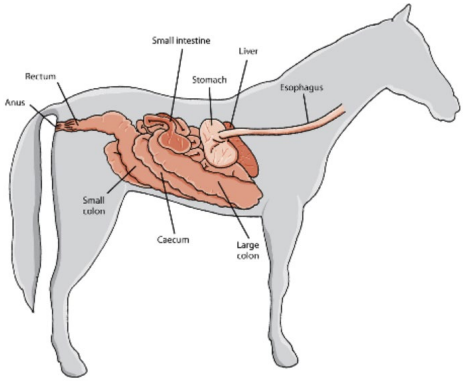
Lecture 1: ILOs

- Describe the relationship between cells, tissues, organs and body systems in terms of their anatomical structure and physiological functions
- Describe the basic structure of a cell and understand the function of the major cell components
- Explain the general concept of homeostasis and the principles of positive and negative feedback in physiological systems





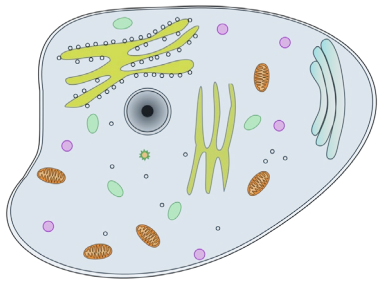




Cells → Tissues → Organs → Organ Systems → Organism

Cells → Tissues → Organs → Organ Systems → Organism

- The basic structural and functional units of life



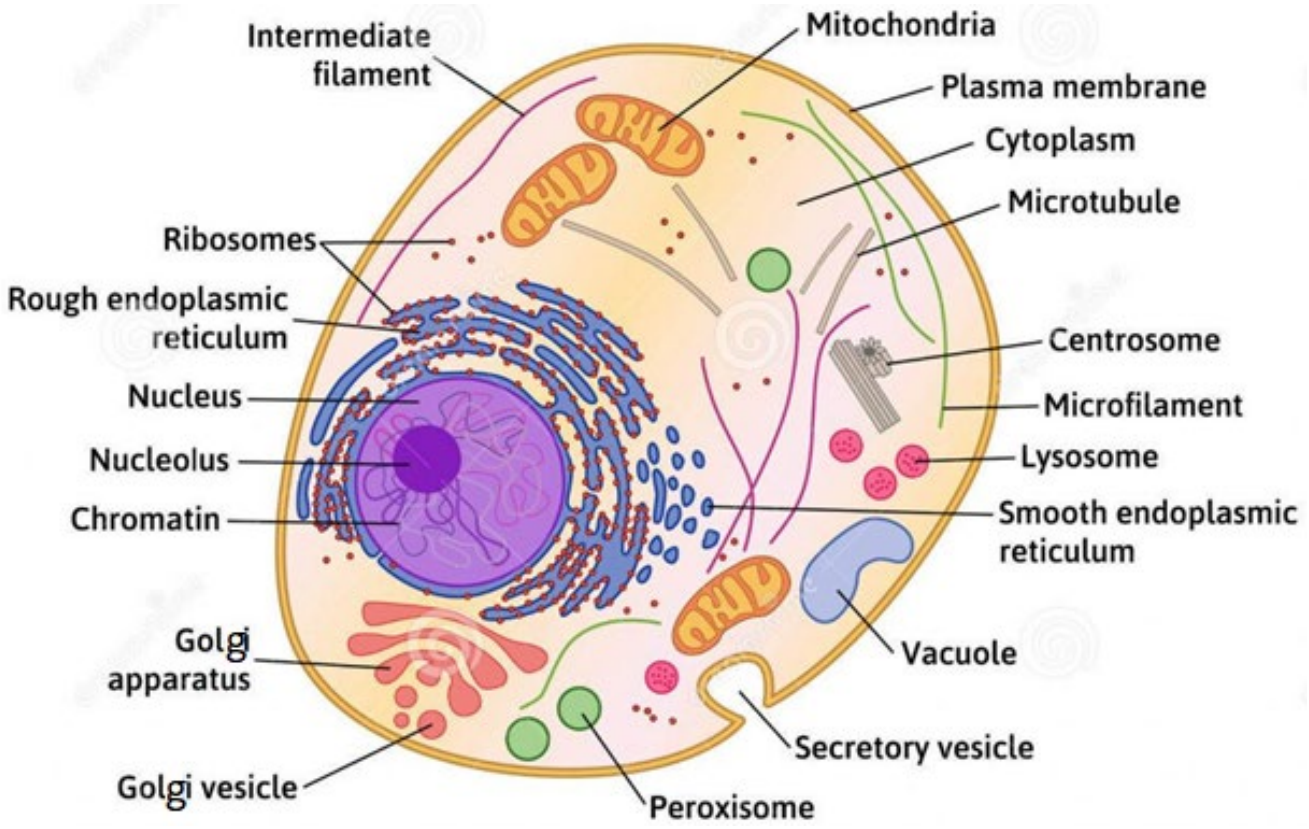
- Perform basic functions such as
  - obtaining nutrients and oxygen,
  - producing energy from nutrients
  - eliminating wastes,
  - synthesising proteins
  - controlling the movement of molecules into the cell
  - growth

- Cells are ***differentiated*** to perform a wide range of specialist functions

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

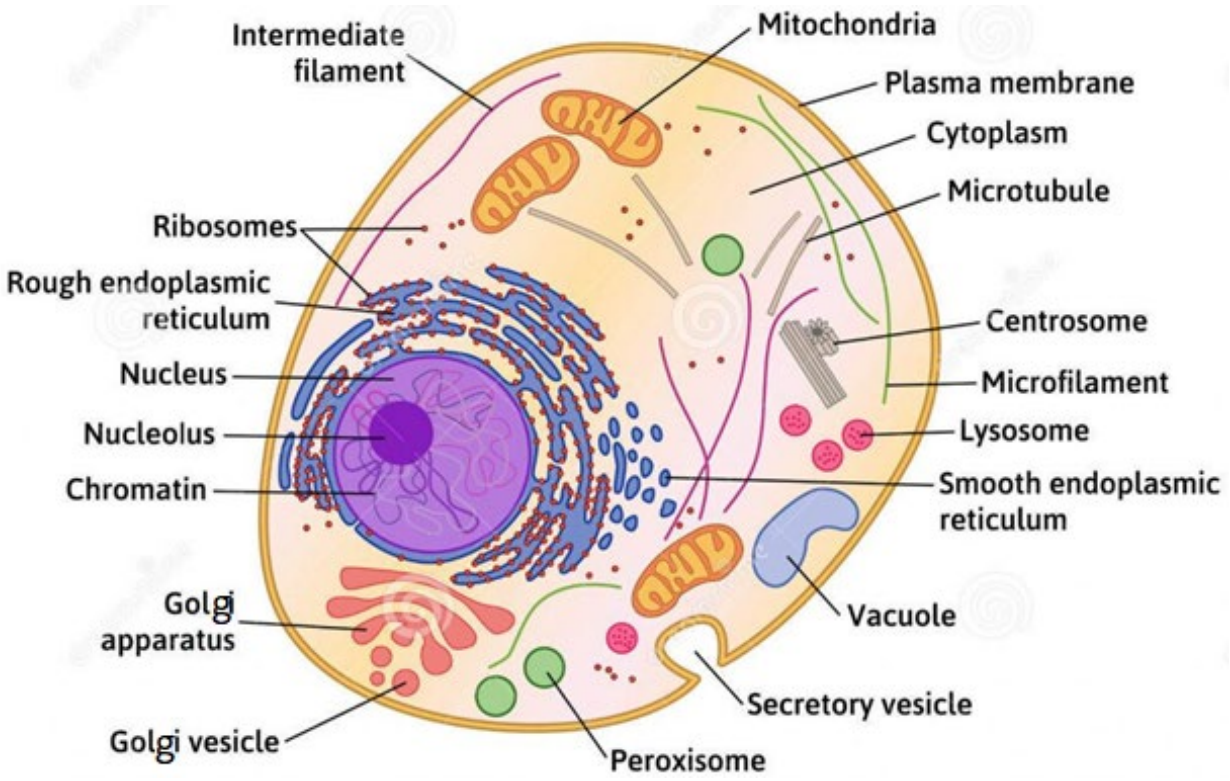
Basic Cell Structure



THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



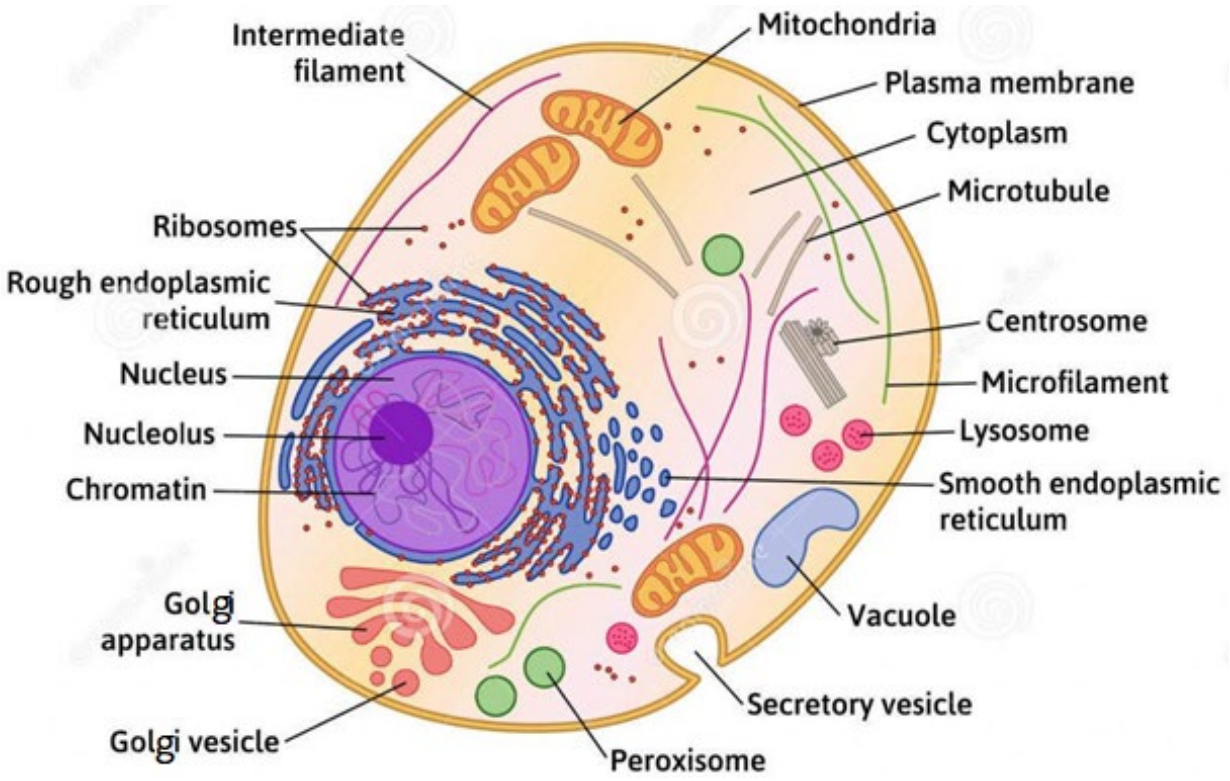
Cell membrane:

- Thin membrane that encloses cell
- Selectively controls movement of molecules between ICF and ECF

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



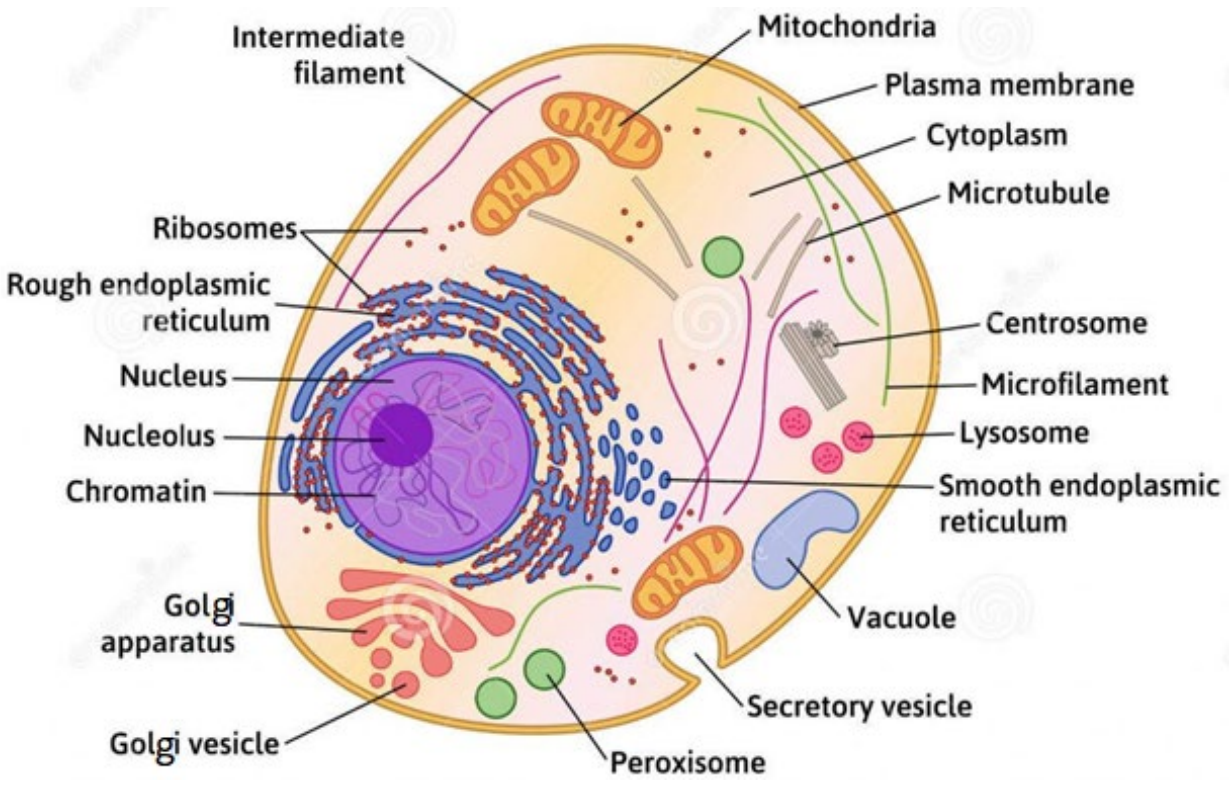
Nucleus:

- Contains the cell's DNA: control centre of the cell
- DNA – protein complex is called chromatin
- Nucleolus: site of ribosome assembly

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



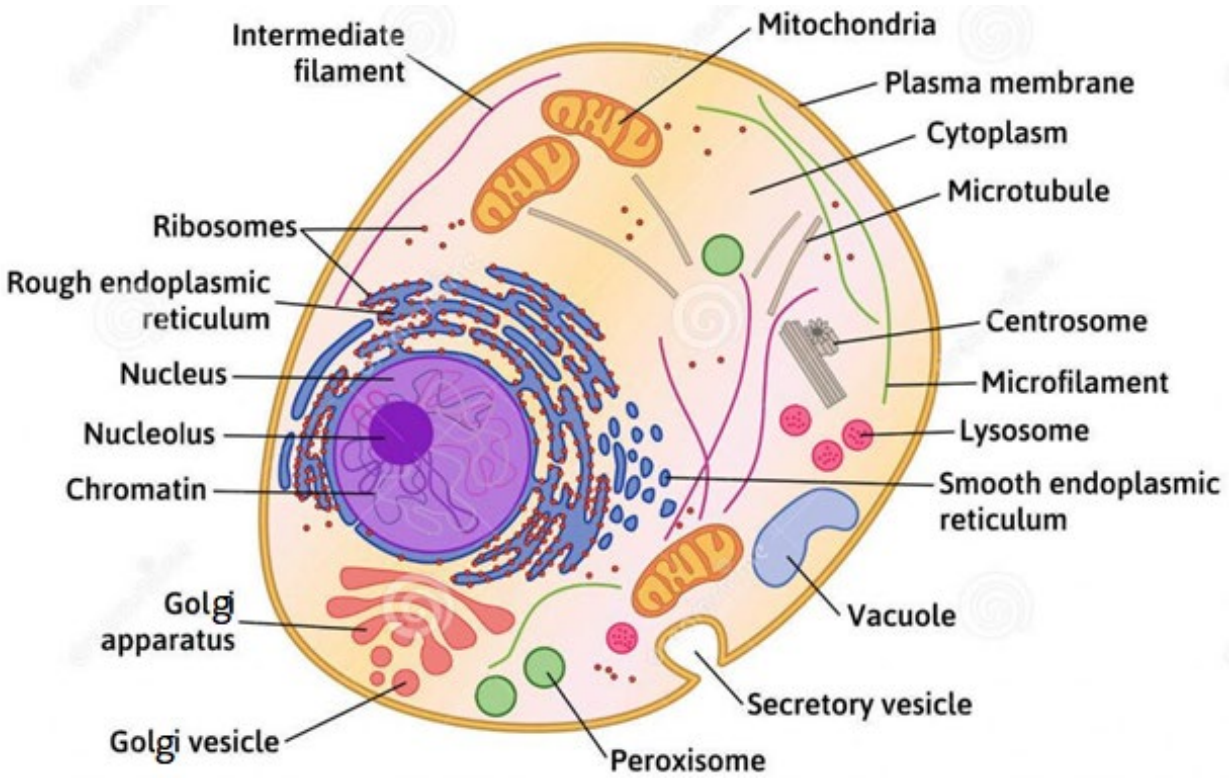
Endoplasmic Reticulum:

- Membranous system of fluid-filled tubules and sacs
- Rough ER: ribosomes attached, synthesises proteins for secretion and membrane construction
- Smooth ER: no ribosomes, carbohydrate metabolism and lipid synthesis

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



Golgi Apparatus:

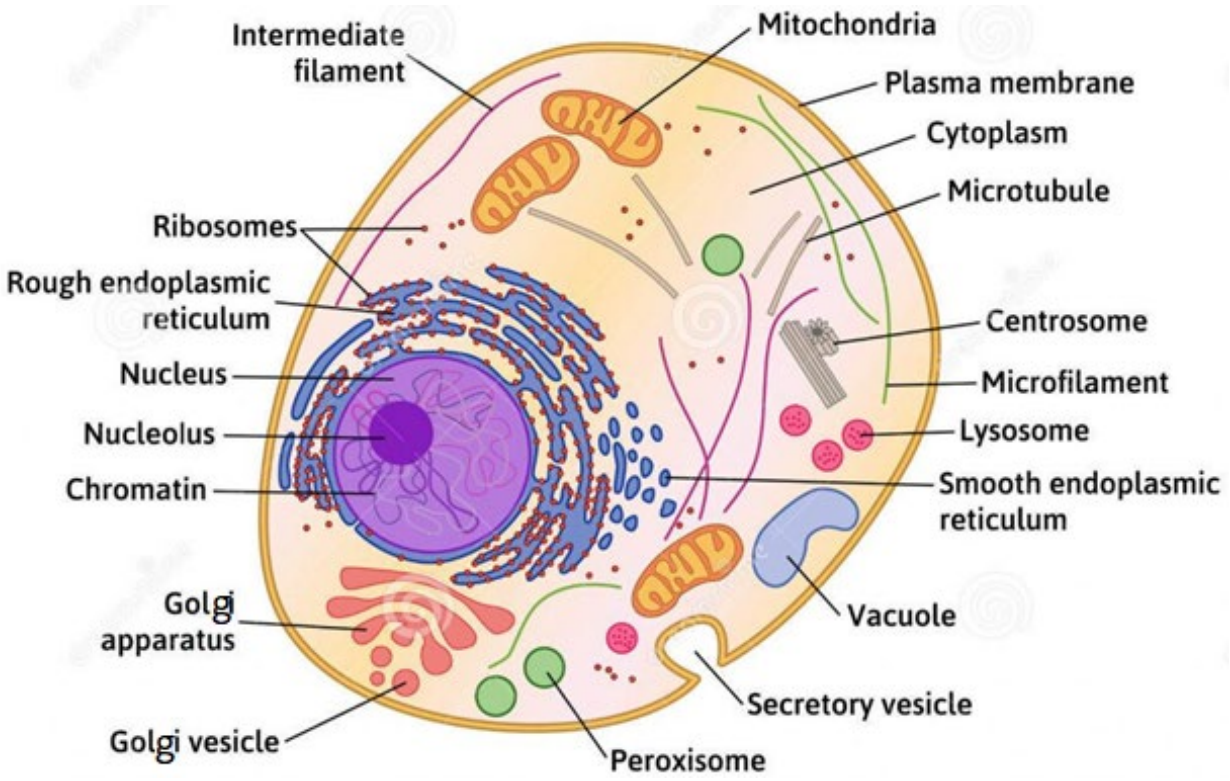
(Golgi complex, Golgi body)

- Post-translational modification of proteins
- Packaging of proteins and lipids – especially for export

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



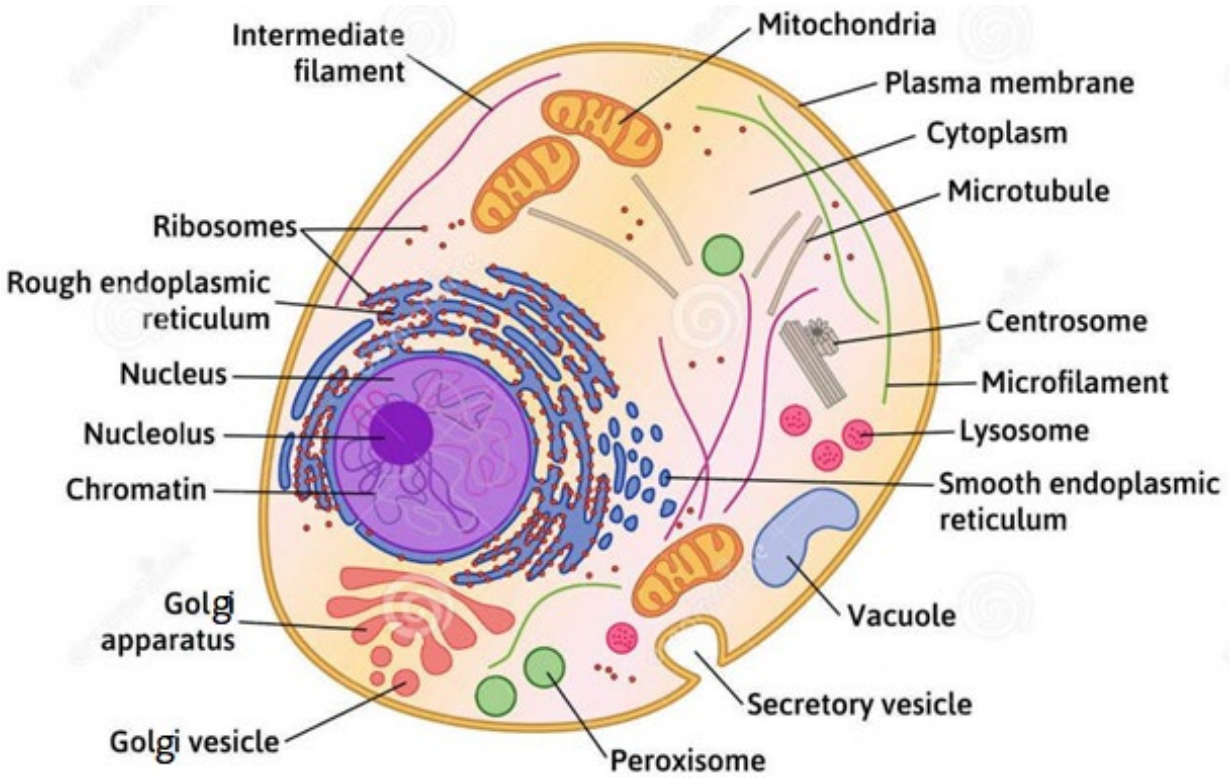
Mitochondria:

- ‘Power plants’ of the cell : generate energy for cellular functions
- Site of oxidation of carbohydrates and lipids

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



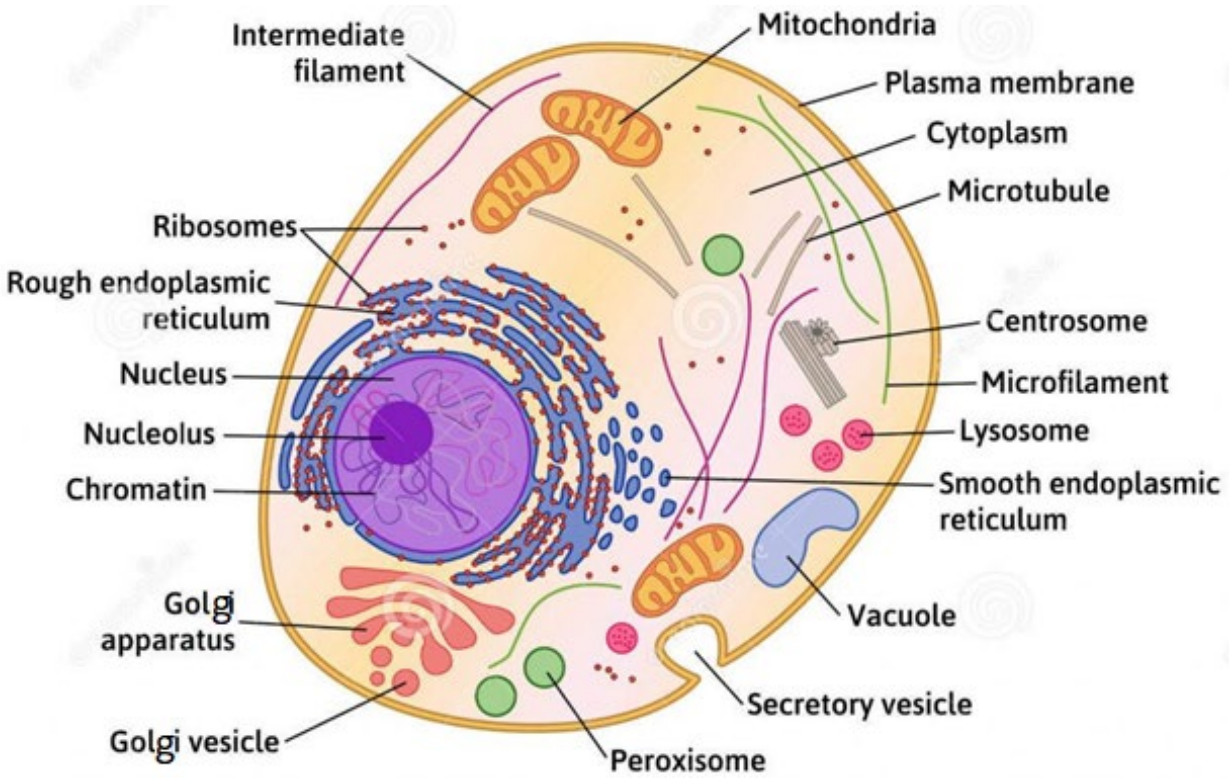
Ribosomes:

- Synthesise proteins from mRNA under the direction of nuclear DNA
- Some are attached to RER, others are ‘free’ in the cytosol

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



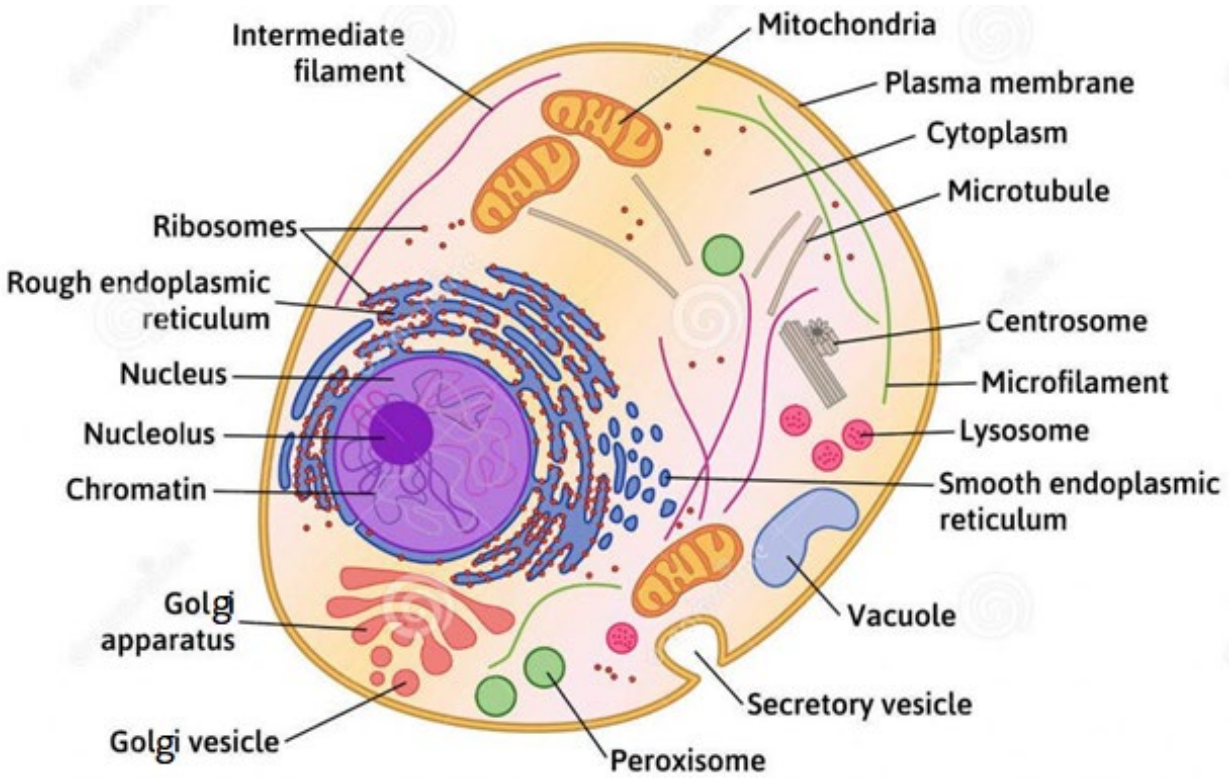
Lysosomes:

- Intra-cellular digestive system
- Sacs containing enzymes that digest cellular macromolecules

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Basic Cell Structure



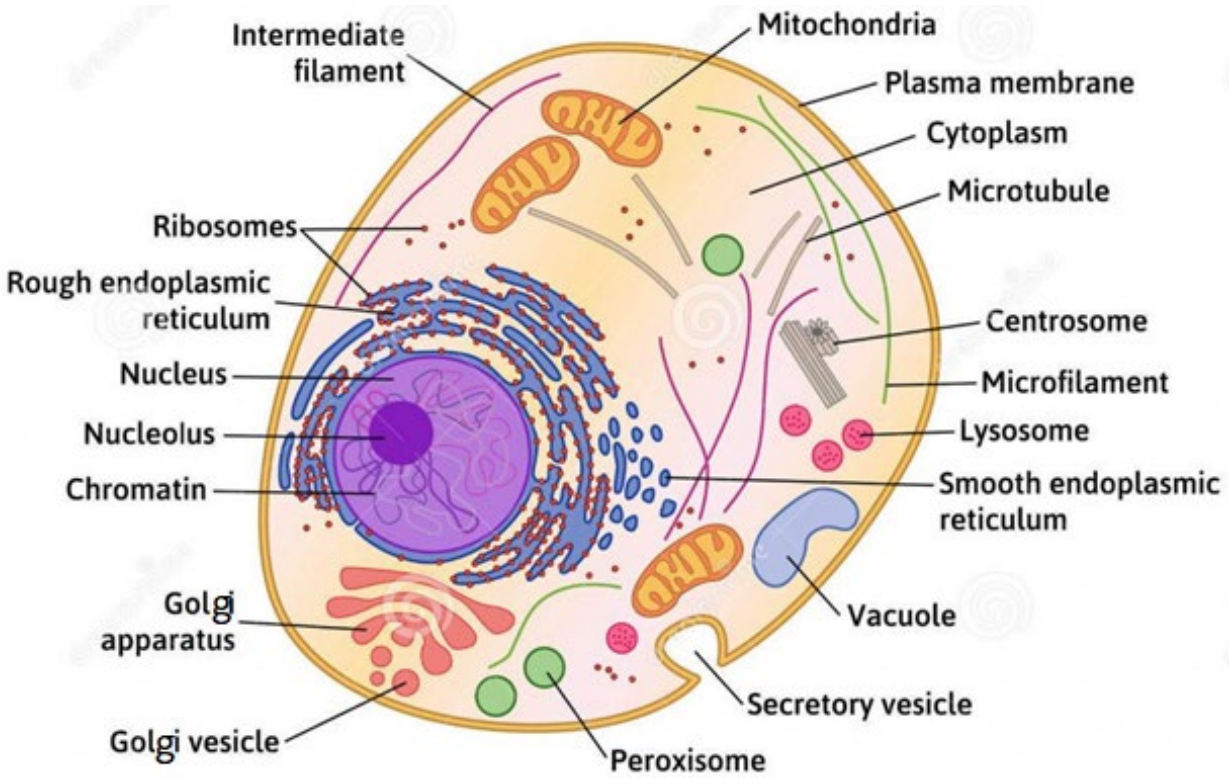
Peroxisomes:

- Sacs containing enzymes which detoxify cellular wastes

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

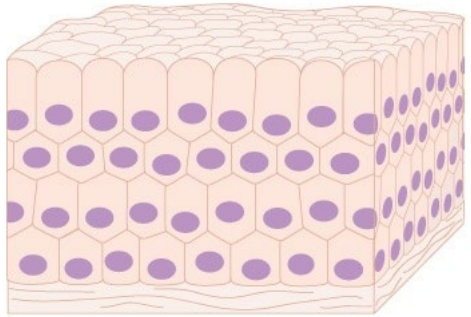
Basic Cell Structure



Cytoskeleton:

- Intracellular scaffolding to support ad organise cellular components
- Includes microtubules, microfilaments and intermediate filaments

Cells | **Tissues** | Organs | Organ Systems | Organism

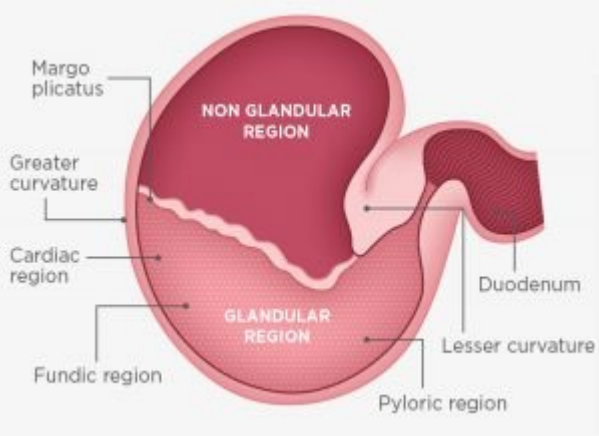


- Tissues are groups of cells that carry out a similar function

- There are four primary types of tissues:
  - *Nervous tissue*: cells specialised in initiating and transmitting electrical impulses
  - *Epithelial tissue*: cells specialised in the exchange of materials between the cell and environment
  - *Connective tissue*: cells and extracellular material specialised for connecting and supporting
  - *Muscle*: cells specialised for contraction

Cells → Tissues → **Organs** → Organ Systems → Organism

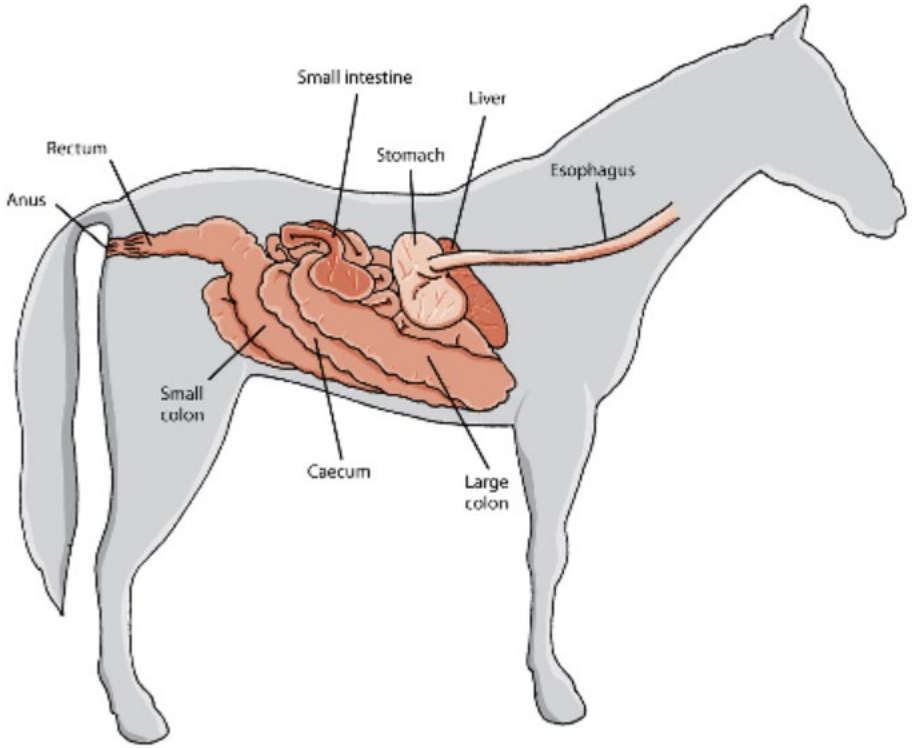
- Organs are two or more types of tissue organised together to perform specific functions



Example: *the stomach*

- Lined with epithelial tissue that controls absorption and secretion
- Wall contains smooth muscle tissue to contract the stomach
- Wall also contains nervous tissue with controls the frequency of contraction
- Tissue types are bound by connective tissue

Cells → Tissues → Organs → **Body Systems** → Organism



- Body systems are groups of organs that perform related functions

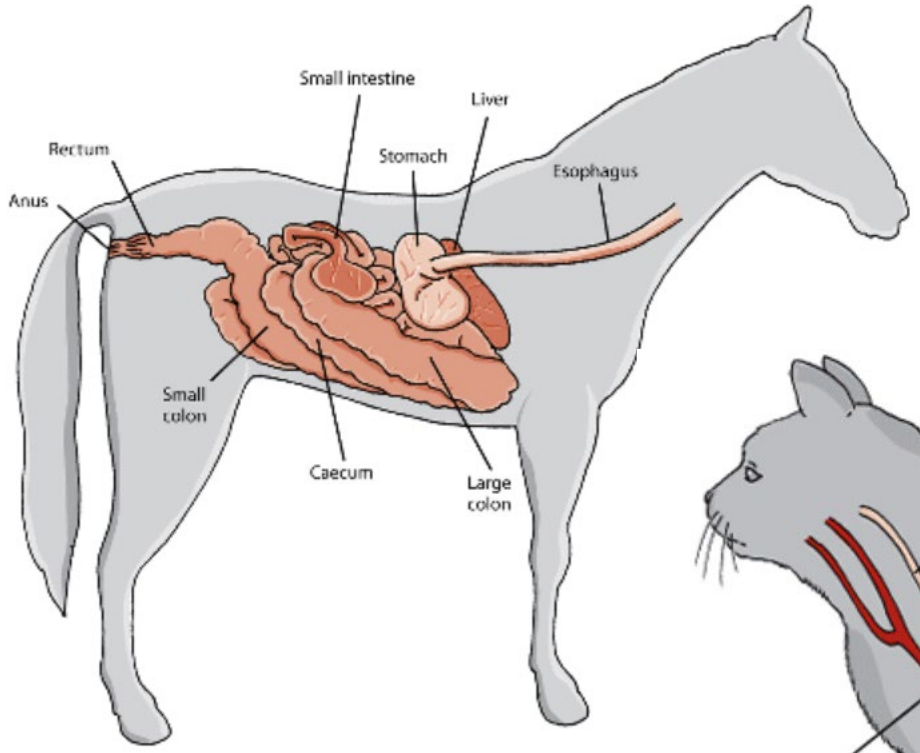
- Example: the digestive system, which includes:
  - Mouth, salivary glands, pharynx
  - Oesophagus, stomach, intestines
  - Pancreas, liver and gallbladder

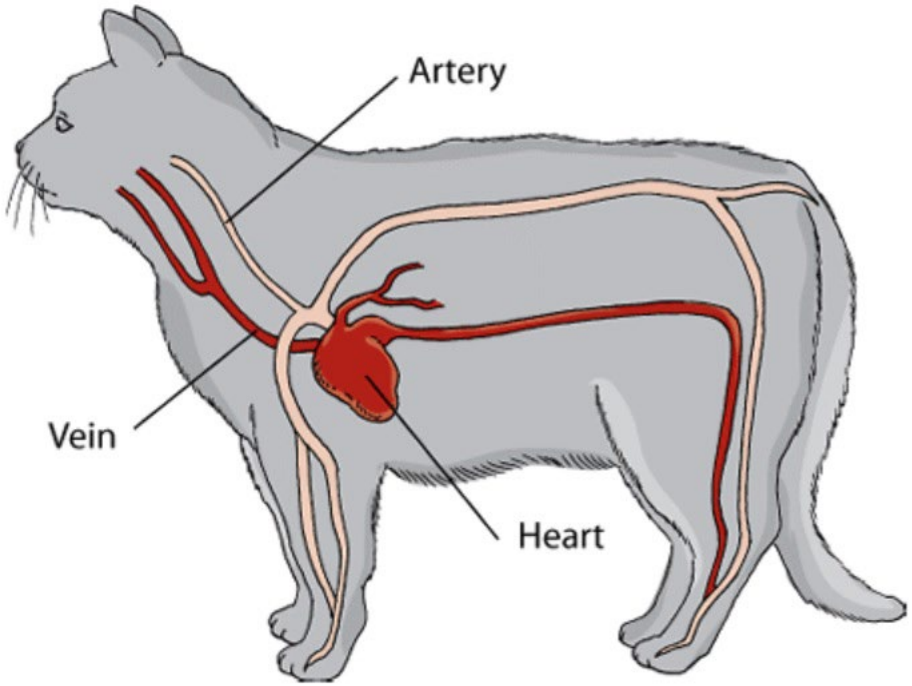
THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Body systems

- Musculoskeletal
- Digestive
- Cardiovascular
- Respiratory
- Integumentary
- Immune & Lymph
- Nervous
- Urinary
- Endocrine
- Reproductive





THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Your studies in Veterinary Biosciences are organised by body system

DVM1

- Digestive
- Cardiovascular
- Respiratory
- Urinary
- Endocrine

DVM2

- Integumentary
- Immune & Lymphatic
- Musculoskeletal
- Nervous
- Reproductive

Cells → Tissues → Organs → Body Systems → **Organism**

- Body systems are packaged together to form the organism
- Many complex body processes require interactions of multiple body systems

A critical skill for all veterinarians is the ability to integrate their understanding of how the body systems work together across the organism to form a cohesive whole

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Cells to Systems Lecture 1: Introduction Video 2

VETS30015 / VETS90121

Dr Laura Dooley
Senior Lecturer

laura.dooley@unimelb.edu.au

Lecture 1: ILOs

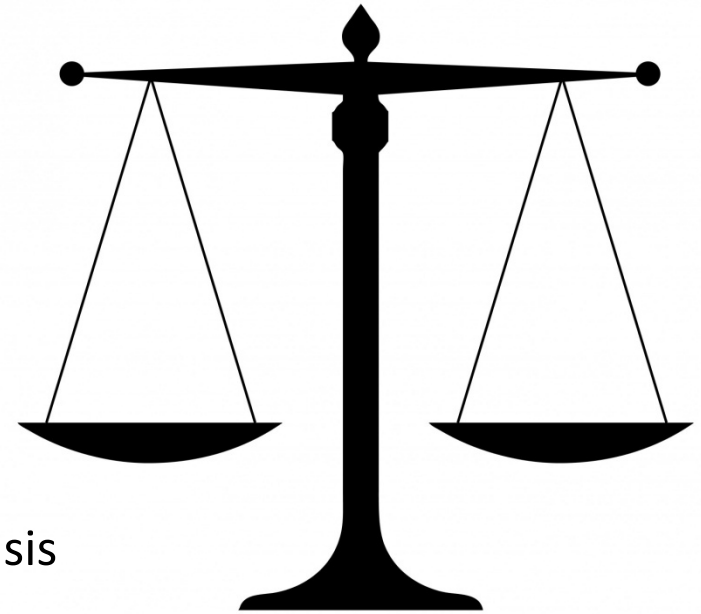
- Describe the relationship between cells, tissues, organs and body systems in terms of their anatomical structure and physiological functions
- Describe the basic structure of a cell and understand the function of the major cell components
-

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

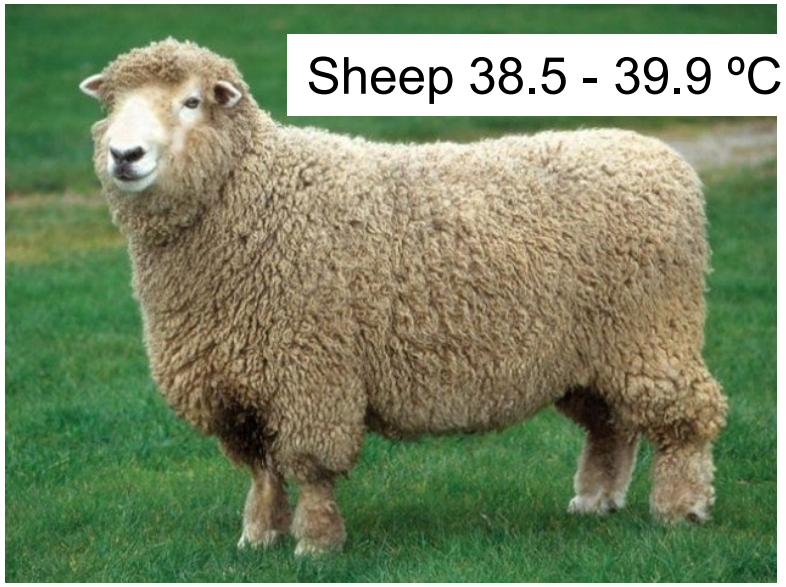
Homeostasis

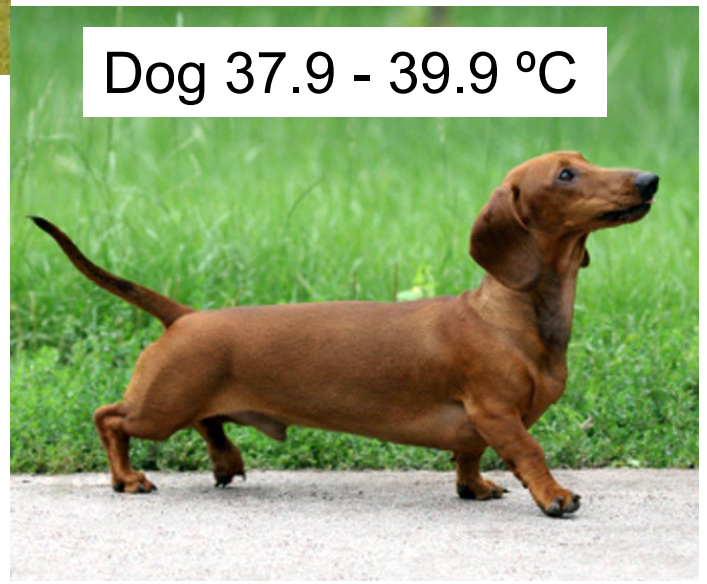
*Homeostasis is the ability of physiological systems to maintain conditions within the body in a **relatively** constant state of equilibrium*



- Dynamic process – internal environment is constantly adjusting
  - For example: pH, oxygen levels, temperature, fluid volumes, cell numbers
- Body systems work together in an integrated way to maintain homeostasis
- Failure of homeostasis can lead to disease

Homeotherms utilise a range of physiological and behavioural mechanisms to maintain their body temperature within a very narrow range



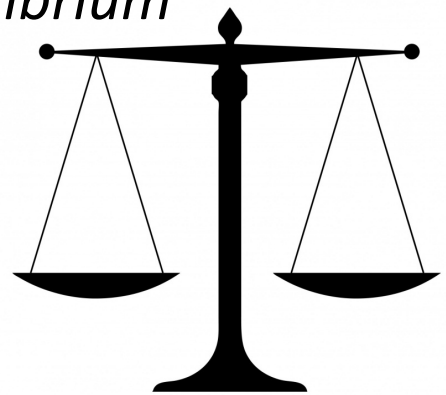


THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Homeostasis

*Homeostasis is the ability of physiological systems to maintain conditions within the body in a **relatively** constant state of equilibrium*

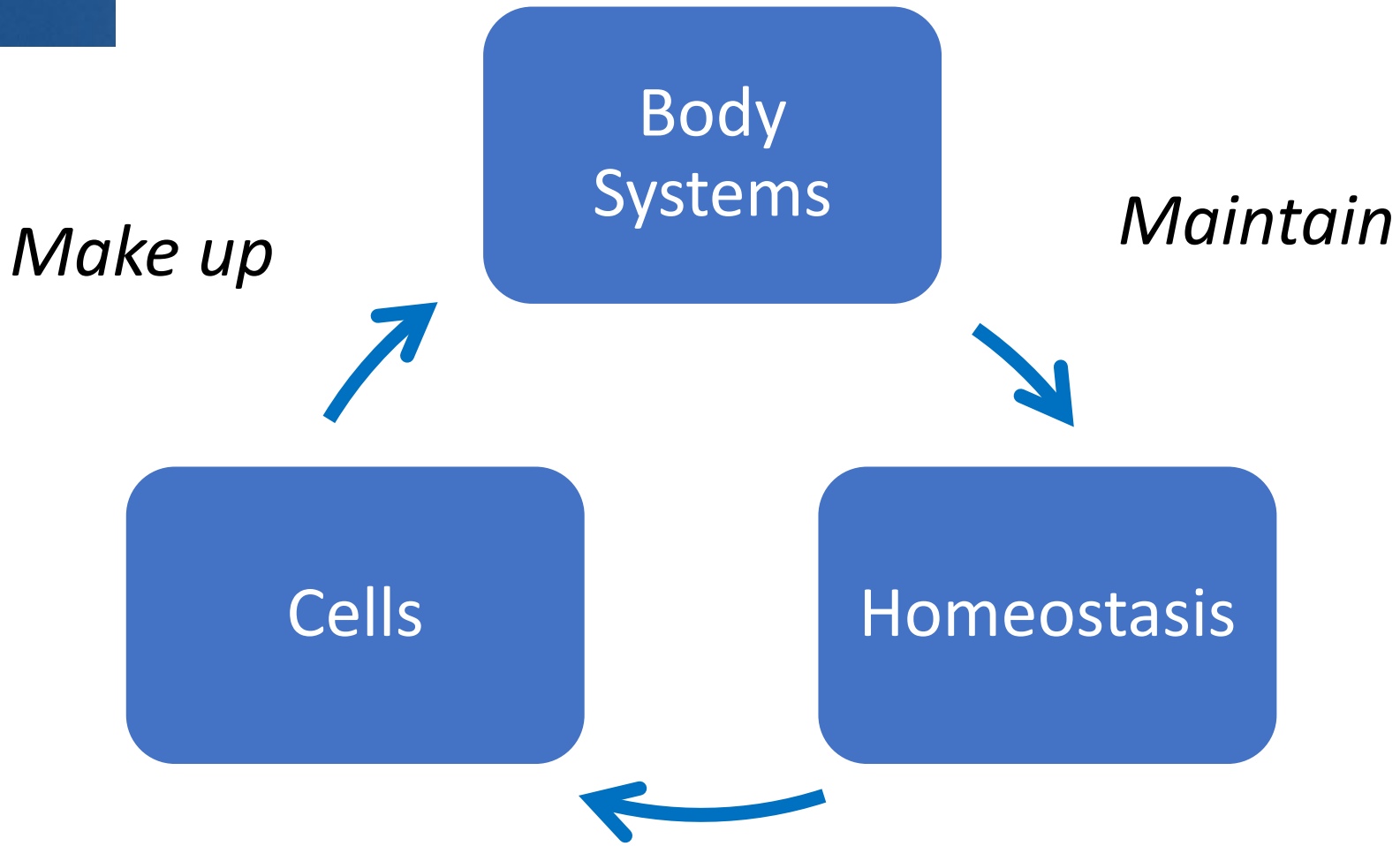


- Dynamic process – internal environment is constantly adjusting
  - For example: pH, oxygen levels, temperature, fluid volumes, cell numbers

- **Body systems work together in an integrated way to maintain homeostasis**

- Failure of homeostasis can lead to disease

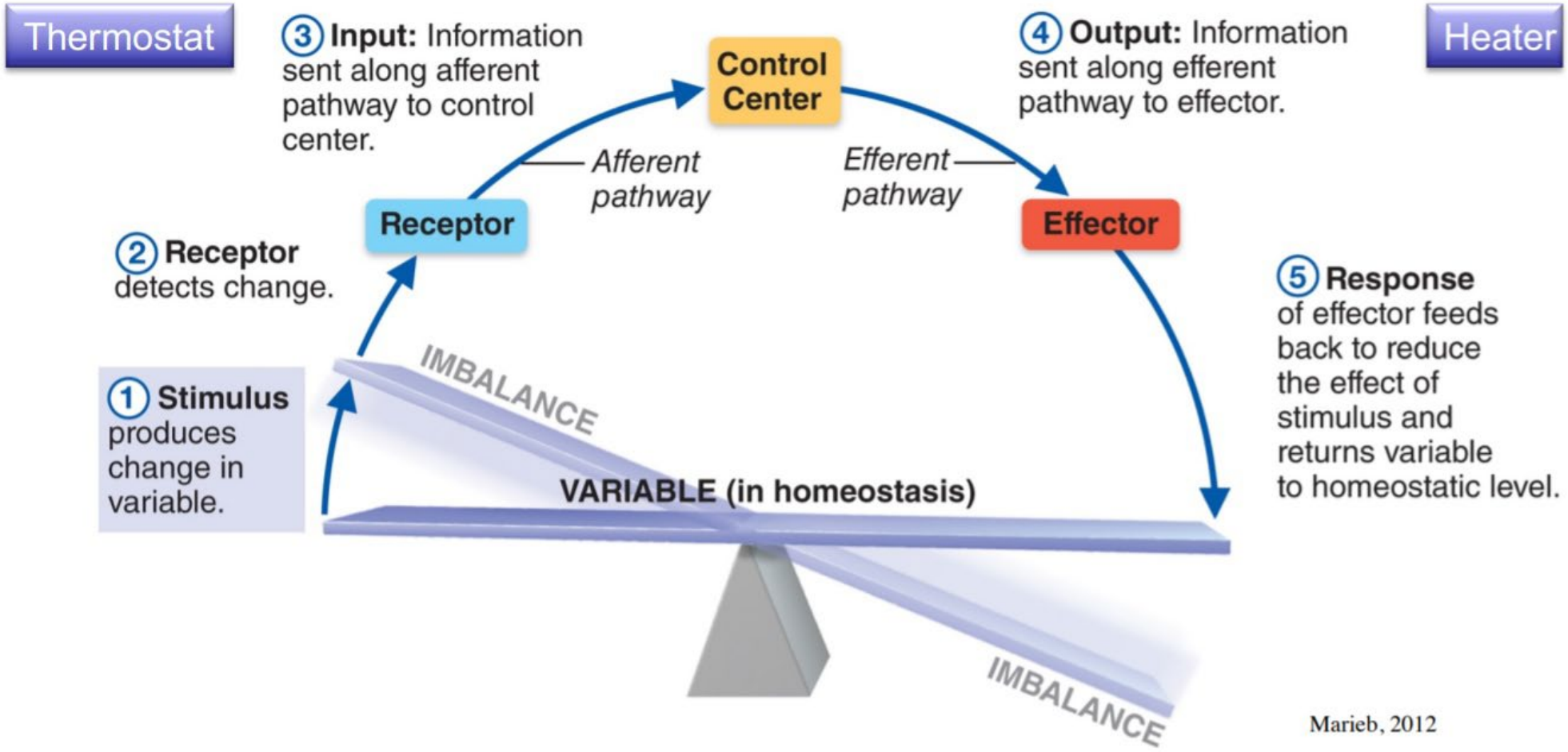
Interdependent relationship between cells, body systems and homeostasis



THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

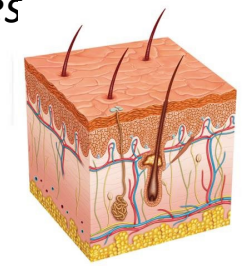
Homeostasis



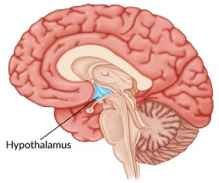
Marieb, 2012

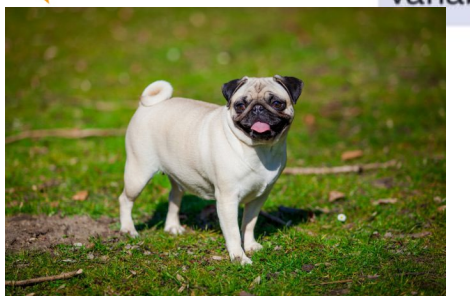
Example: **thermoregulation**

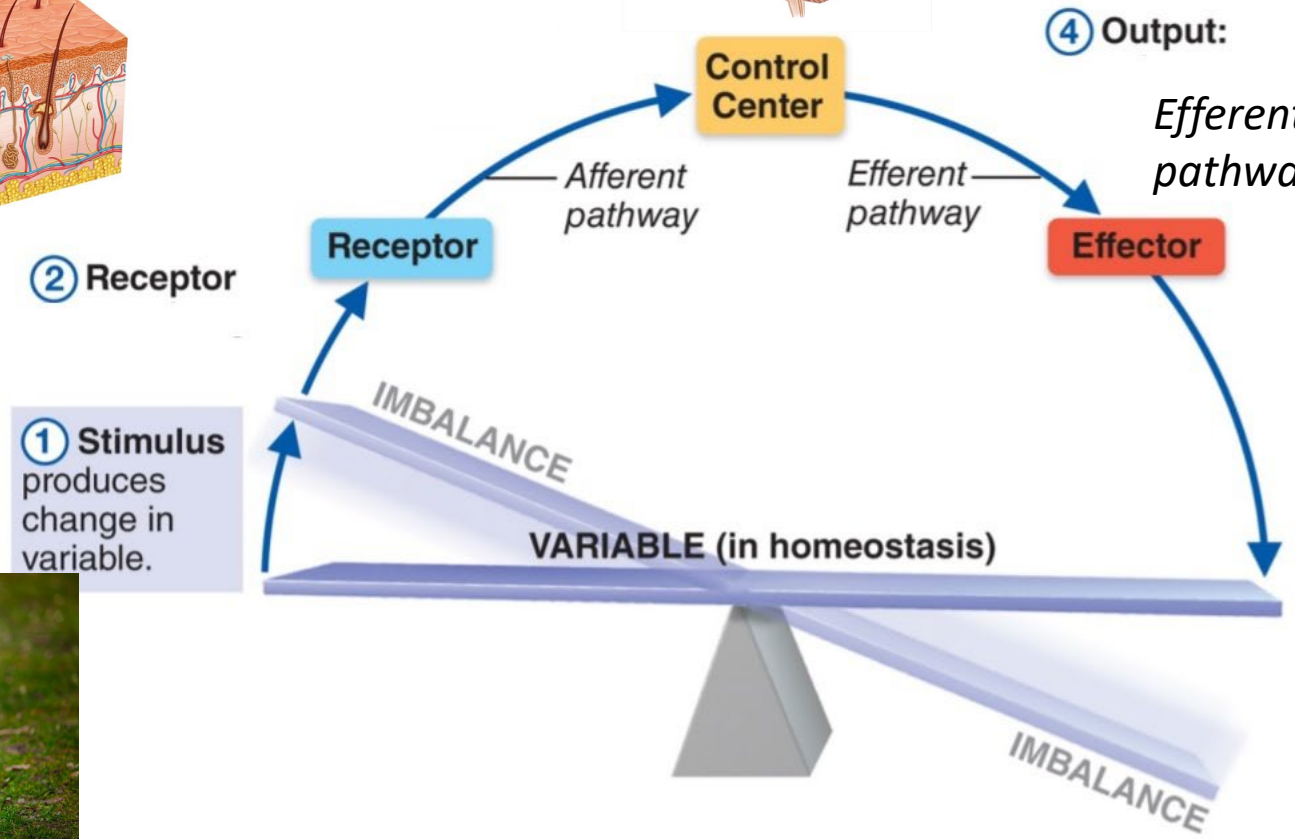
Thermoreceptor sensory fibres located in the skin, skeletal muscles hypothalamus



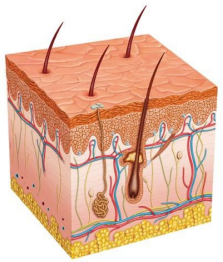
Hypothalamus thermoregulatory centre







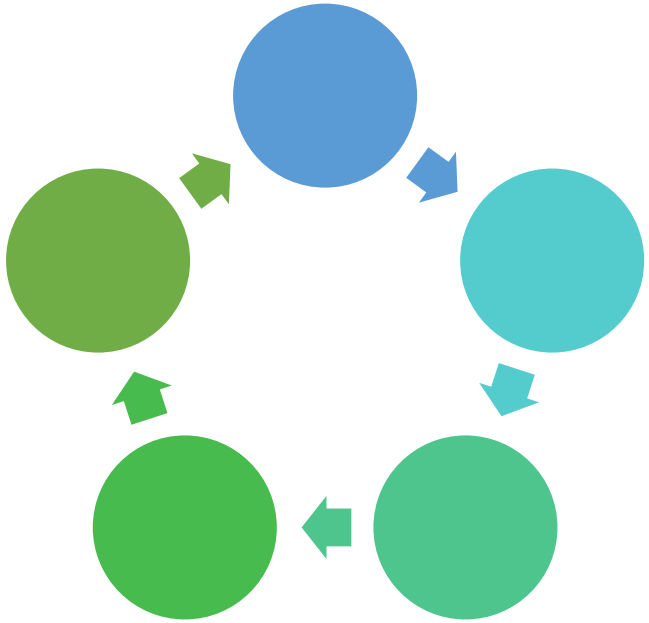
Efferent autonomic pathways



Vasodilation, Panting

Marieb, 2012

Feedback mechanisms



- Homeostasis requires communication – lots of it!
  - Feedback is a critical part of this communication

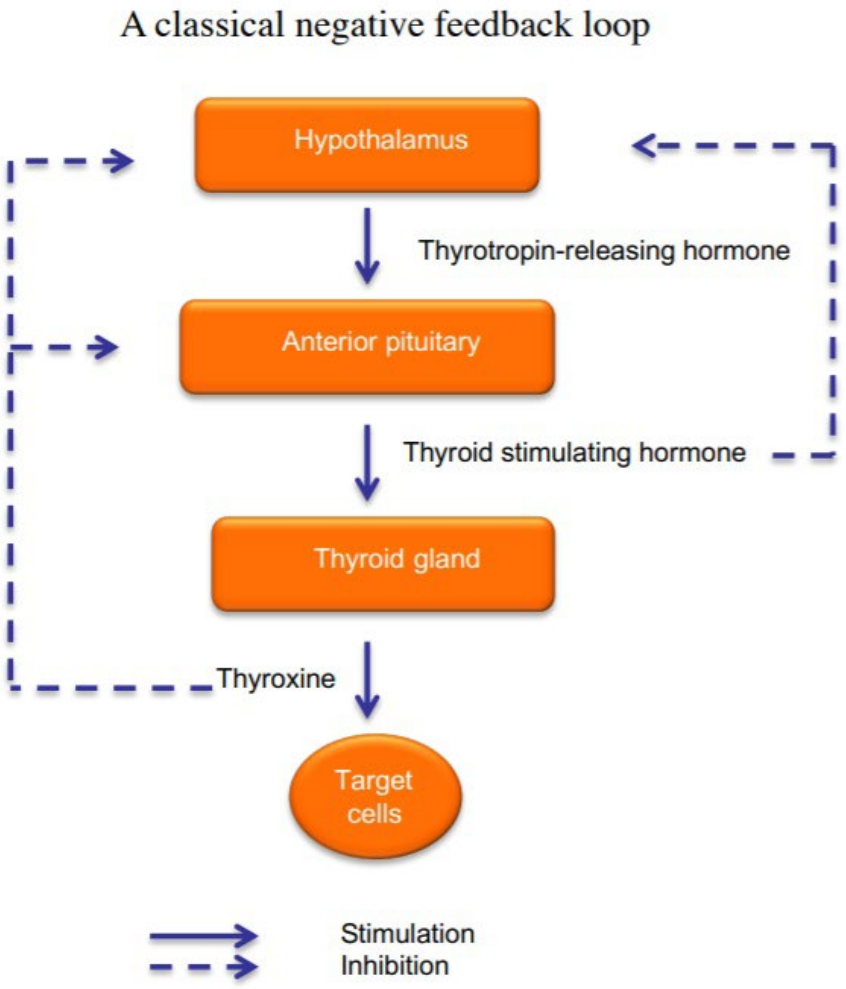
- Negative feedback loops counteract changes that of parameters that have varied from their set points
  - Contributes to maintenance of a relatively steady state (homeostasis!)
  - Disruptions to negative feedback disrupt homeostasis, which can lead to disease

- In contrast, positive feedback amplifies the initial change, which moves the parameter further from its steady state
  - Positive feedback is not as common

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

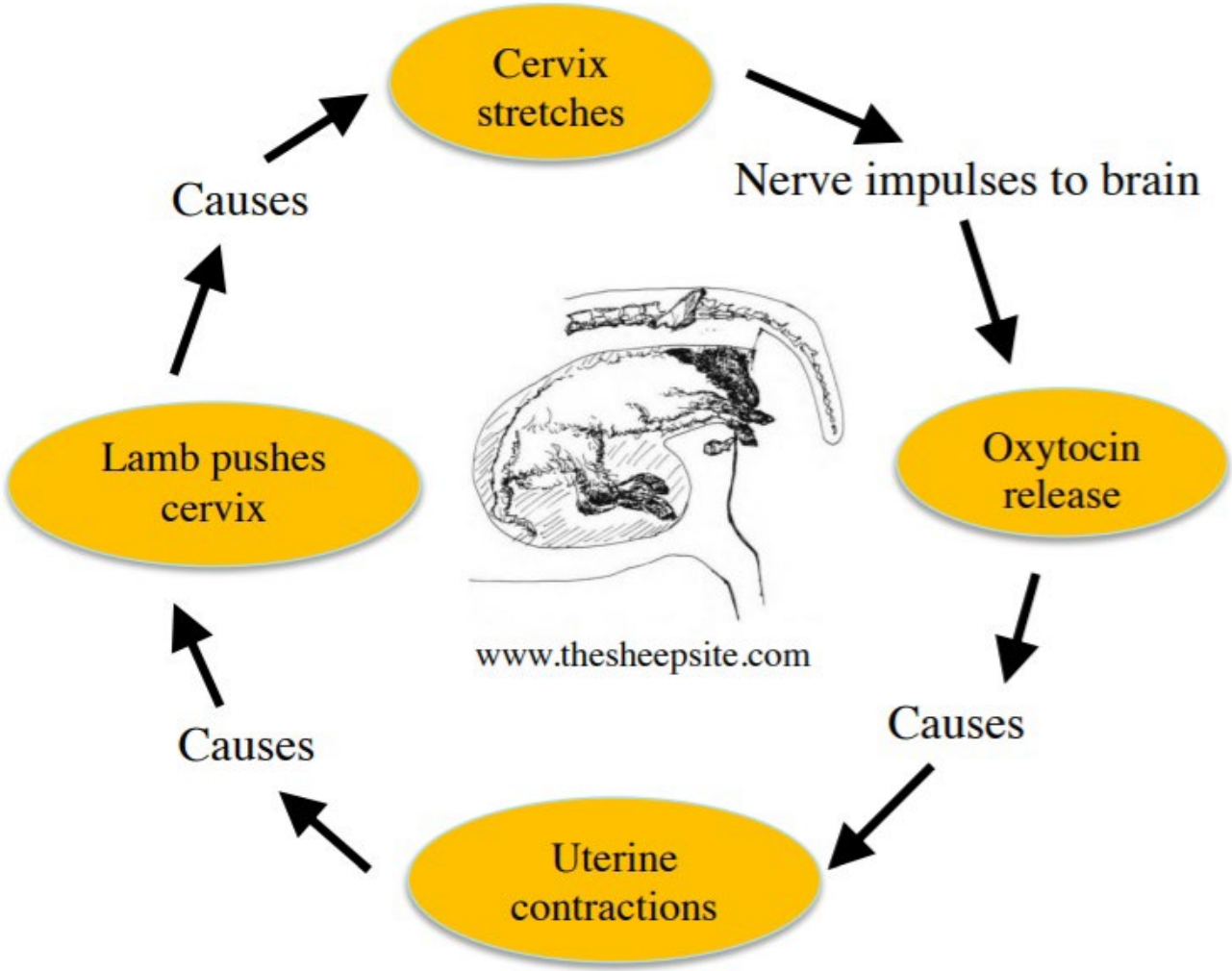
Negative feedback Example: Regulation of thyroid hormones



THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Positive feedback example: birth



Provides rapid amplification, and works well where there is a mechanism to break the feedback loop

Lecture 1: ILOs

- Describe the relationship between cells, tissues, organs and body systems in terms of their anatomical structure and physiological functions
- Describe the basic structure of a cell and understand the function of the major cell components
-

THE UNIVERSITY OF MELBOURNE

Faculty of Veterinary and Agricultural Sciences

Cells to Systems: where are we heading?

Cells to Systems is taught in 10 Themes:

1. Homeostasis and cell types
2. The skeleton and body plan
3. Cell structure and transport of molecules around the body
4. Host defences against injury
5. Cellular responses to injury
6. Chemical communication
7. Electrical communication
8. Receptor pharmacology
9. Growth, development and differentiation
10. Disorders of growth and neoplasia

See you in Week 3!