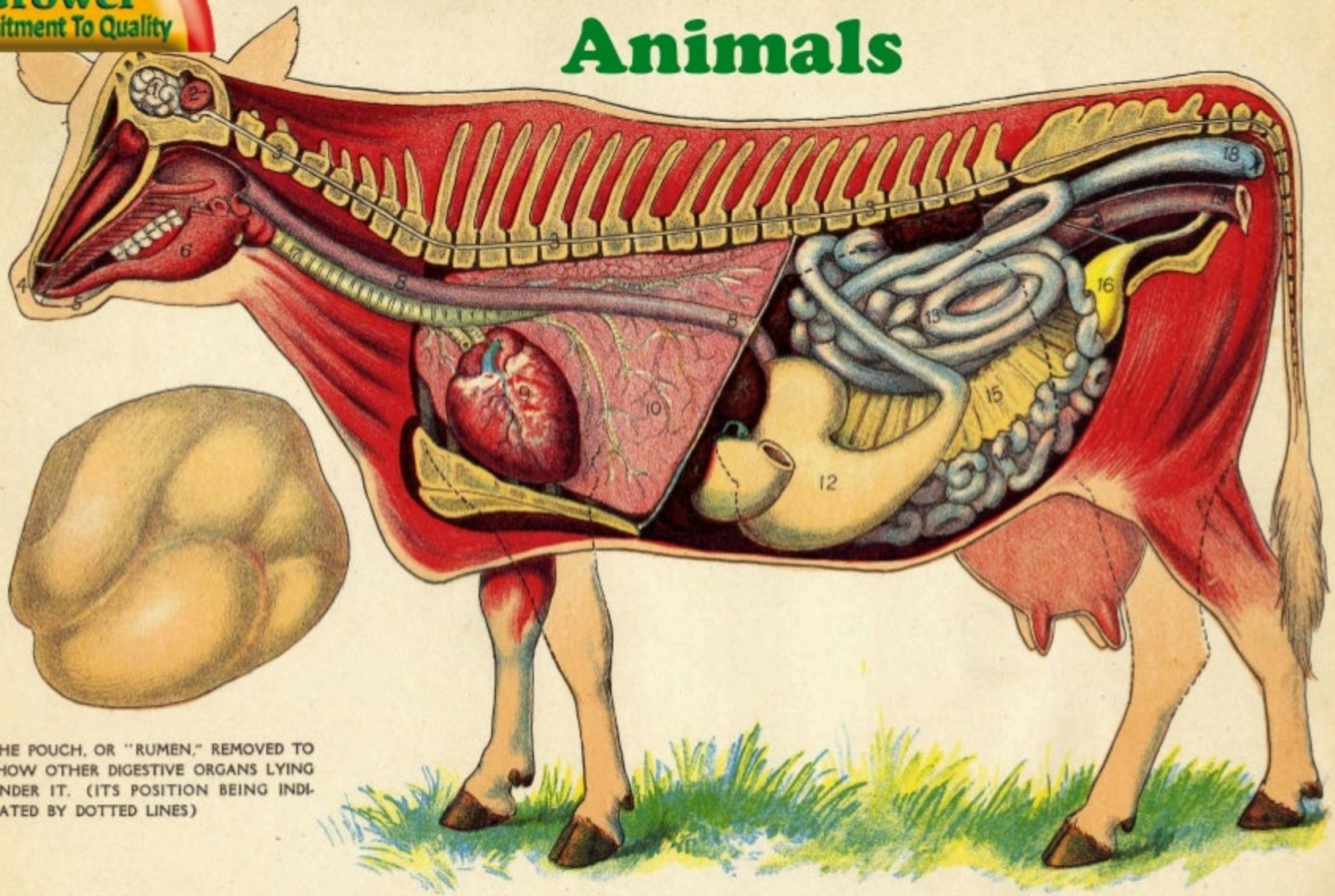
Anatomy & Physiology of Animals



THE POUCH, OR "RUMEN," REMOVED TO SHOW OTHER DIGESTIVE ORGANS LYING UNDER IT. (ITS POSITION BEING INDICATED BY DOTTED LINES)

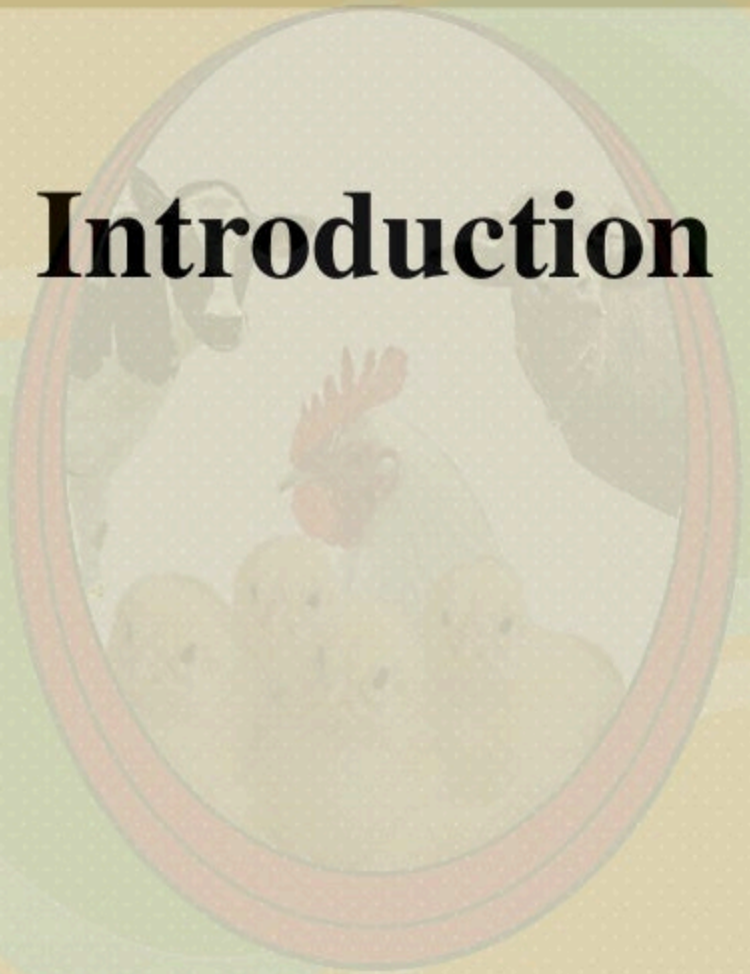
COW

SHOWING INTERNAL ORGANS

Anatomy & Physiology of Animals

- Introduction
- Integumentary System
- Skeletal System
- Muscular System
- Circulatory System
- Digestive System
- Respiratory System
- Nervous System
- Urinary System
- Endocrine System

Introduction



Anatomy

Anatomy is the study of form and structure.

- Gross anatomy is the study of structures that can be seen with the naked eye.

- Microscopic anatomy is the study of structures that require a microscope to be seen.

Physiology

- Physiology is related to the functions of the body and all its parts, including cells, tissues and organs.

- The study of anatomy and physiology is generally divided into the function and integration of ten organ systems.

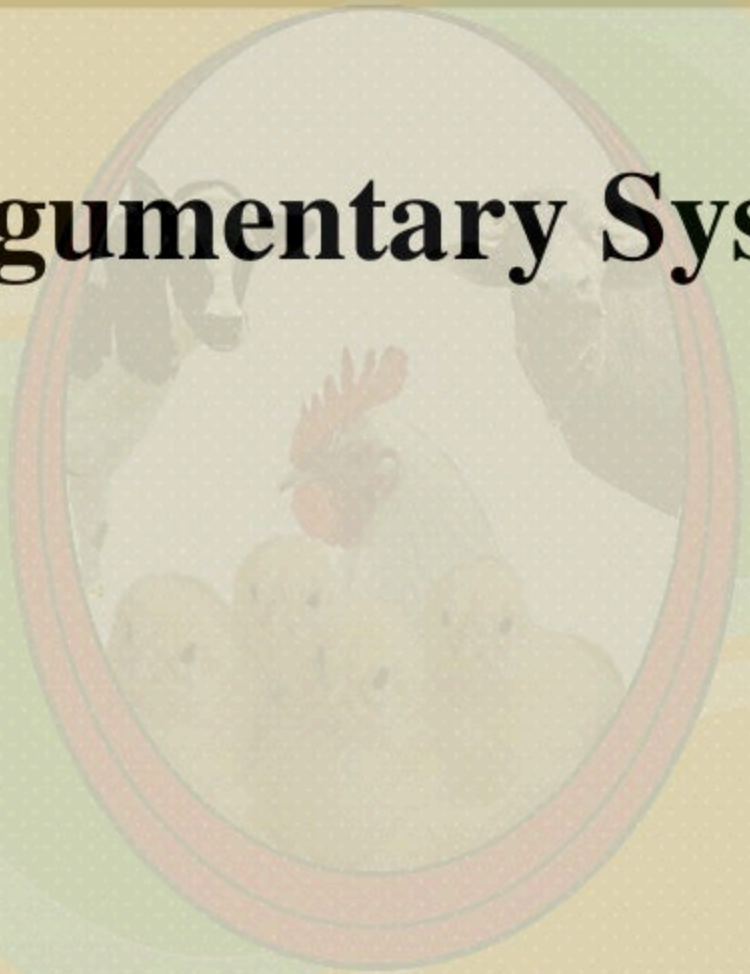
Organ Systems

1. Integumentary system (skin)
2. Skeletal system (bones)
3. Muscular system (muscles)
4. Circulatory system (heart & blood vessels)
5. Digestive system (stomach & intestines)

Organ Systems

6. Nervous system (nerves)
7. Respiratory system (lungs & passageways)
8. Urinary system (kidneys & bladder)
9. Endocrine system (glands & hormones)
10. Reproductive system (organs involved in producing offspring)

Integumentary System



Integumentary System

The integumentary system is the exterior covering of the body and is essential for:

- Regulating body temperature
- Balancing water
- Protecting internal organs

Integumentary System

The integumentary system consists of skin and skin appendages, including:

- Hair
- Nails
- Horns
- Sebaceous glands
- Sweat glands

Skin (Function)

- The primary function of skin is to act as a protective layer against disease, infection, the sun, and other potentially harmful elements.

Skin (Epidermis)

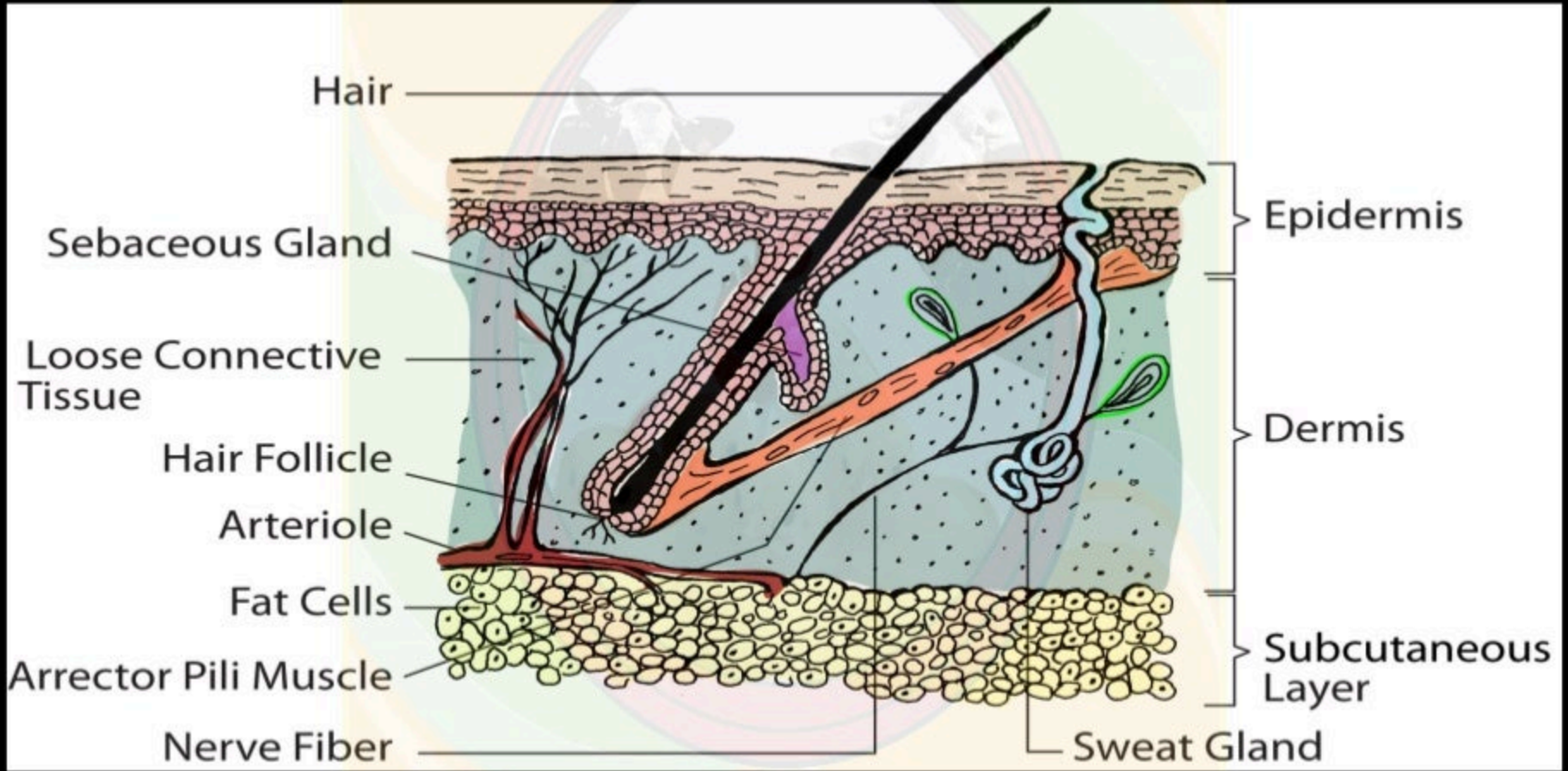
- The skin of animals consists of two layers, the epidermis and the dermis.
- The epidermis is the outer layer of the skin and contains no blood cells.
- The epidermis is a superficial covering of stratified epithelial tissue comprised of an external layer of dead cells sitting on a lower layer of living cells.

Skin (Dermis)

- The dermis is the inner layer of the skin and contains blood vessels, lymph vessels, nerves, glands, hair follicles, and muscle fibers.

- The dermis is a deeper layer of dense, irregular connective tissue.

Skin



Skin

Skin Appendages (modified extensions) derived from the skin include:

- Hair
- Scales
- Hoofs
- Feathers
- Claws
- Horns
- Nails

Skin

- Coat coverings differ between animals species.
- Goats, horses, cattle, and swine have hair; sheep have wool, and poultry have feathers.
- Hair, wool and feather are all comprised of protein and are essential for regulating body temperature.

Skin

- Each hair follicle has a small bundle of smooth muscle fibers (arrector pili) that can contract to pull the hair perpendicular to the skin surface.

- The arrector pili muscles are stimulated to contract involuntarily by the nervous system in times of stress or cold.

- When all hairs are standing perpendicular, they trap more air and keep the animal's body warmer.

Glands

- The principle glands of the skin are sweat glands and sebaceous glands.
- Sweat glands release water to cool the body.
- Sebaceous glands secrete oil substances to lubricate the skin and hair.

Sensory Receptors

Sensory receptors in the dermis of the skin detect touch, pain, heat, and cold. Sensory receptors include:

- Merkel cells
- Meissner's corpuscles
- Paccinian corpuscles
- Free nerve endings

Sensory Receptors

- Merkel cells respond to very light pressure.
- Meissner's corpuscles are sensitive to touch and are found in delicate areas such as the lips and fingertips.

Sensory Receptors

- Paccinian corpuscles detect pressure.
- Free nerve endings sense heat and cold as well as touch.

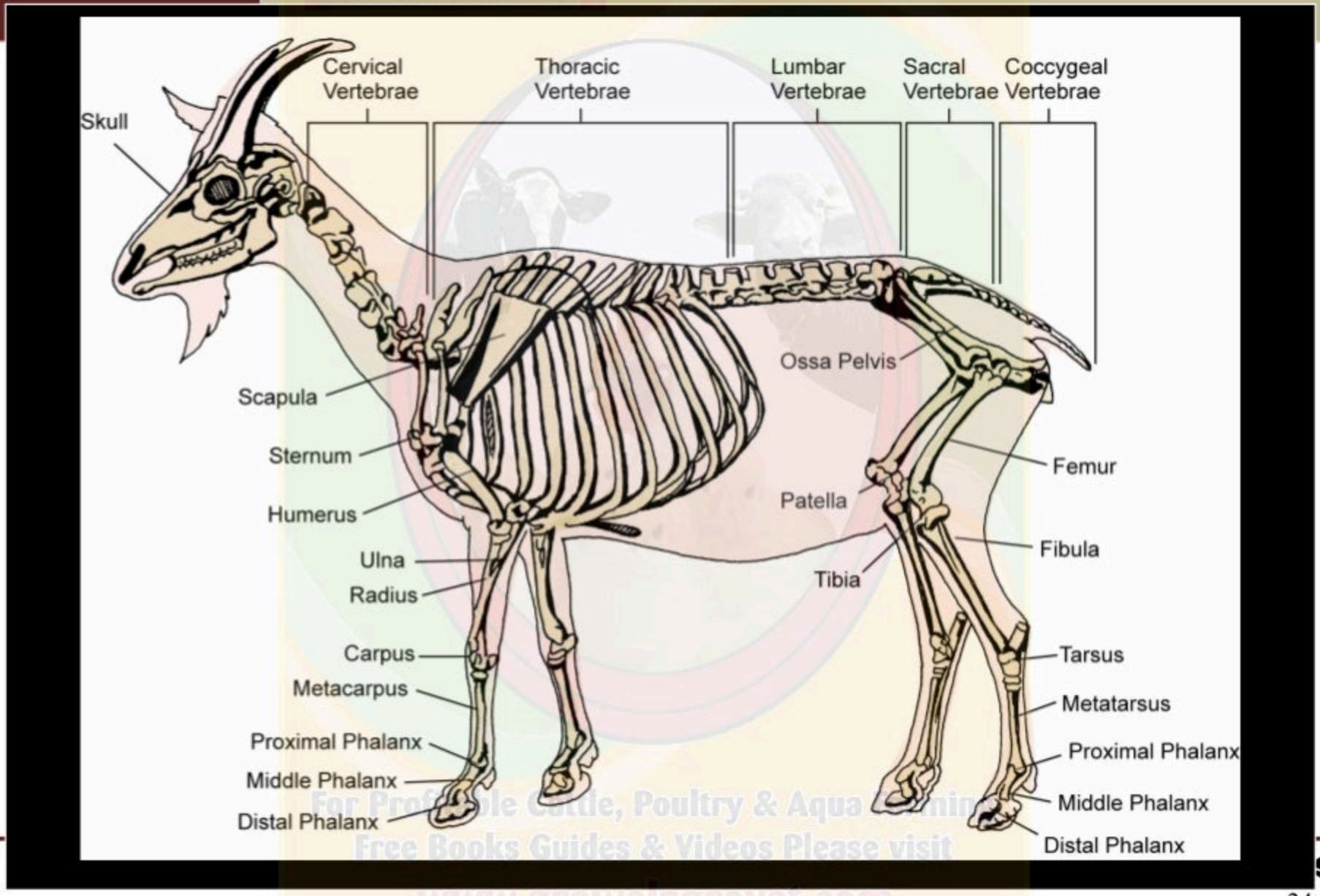
Skeletal System

Skeletal System

- The skeletal system is the framework of the body.

- The skeletal system is made up of bones and connective tissue and provides structural support for all of the other organ systems.

Skeleton of a Goat



Skeletal System

- The skeletal system protects the organs of the body.
- The skull protects the brain, ribs protect the lungs, and vertebrae protect the spinal cord.
- The skeleton also works in conjunction with the muscles to allow movement of the different body parts.

Skeletal System

The skeleton is made up of the axial skeleton and the appendicular skeleton.

The axial skeleton consists of those bones on the midline of the body including:

- Skull
- Vertebrae
- Ribs
- Sternum

Skeletal System

The appendicular skeleton is comprised of those bones coming off the midline of the body including:

- Forelegs (arms)
- Hindlegs (legs)
- Bones in the pelvic region

Bones

Bones are divided into four classes.

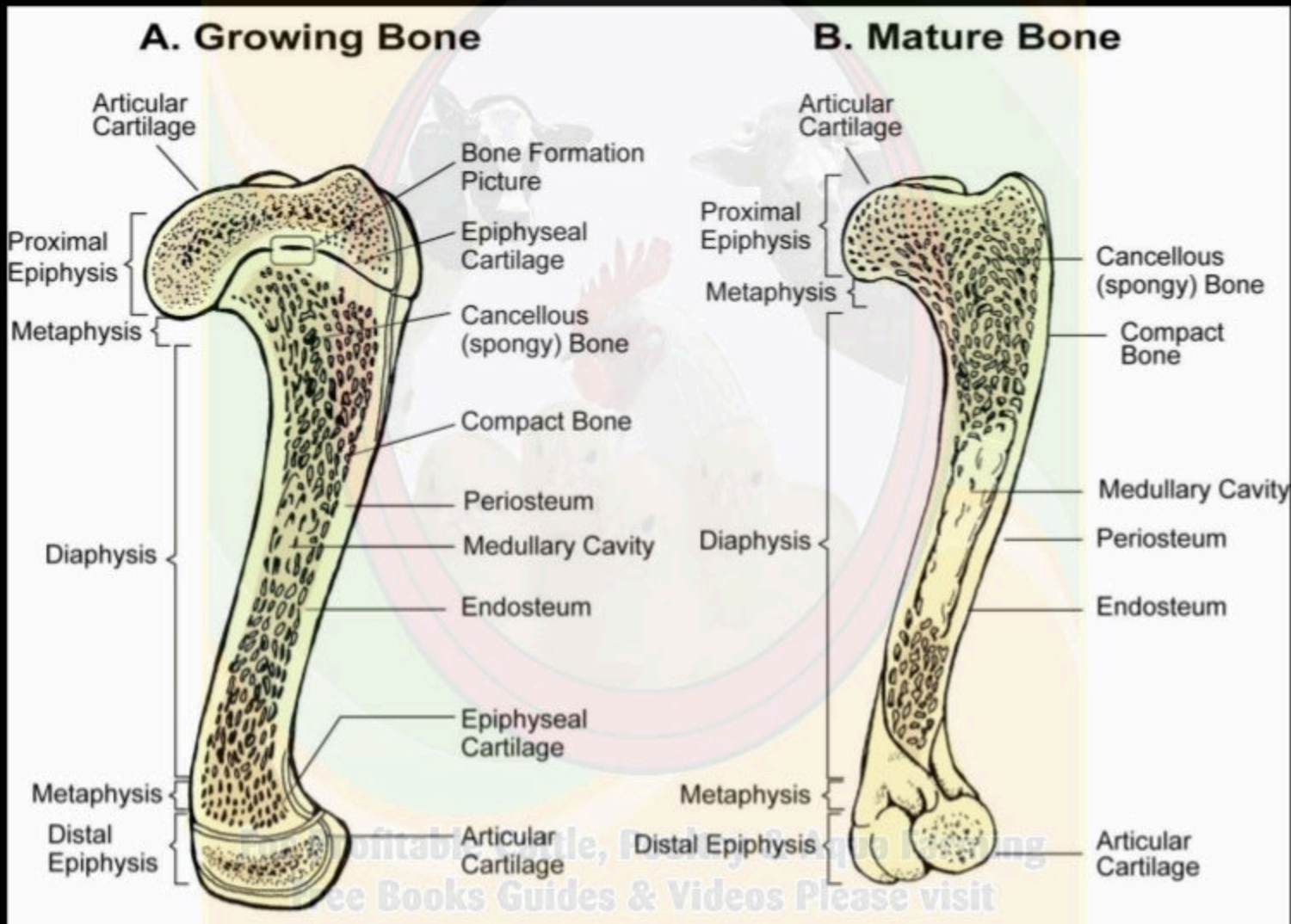
- Long bones
- Flat bones
- Short bones
- Irregular bones

Bones

- Long bones, found in the limbs, are the supporting columns and levers for the skeletal system and the body.

- Flat bones protect the body's organs and serve as an area of muscle attachment.

Longitudinal Section of a Long Bone In a Young Animal



Bones

- Short bones, such as the bones in the knee hock joint, diffuse concussion, diminish friction, and change the direction of tendons.

- Irregular bones are those found in the vertebral column.

Bones

- Bone is made up of organic and inorganic matter.
- The organic matter is mostly collagen and gives bone flexibility and resilience.
- The inorganic matter is mostly tricalcium phosphate and gives bone rigidity and hardness.

Bones

- The inner core of the bone is soft tissue called bone marrow.

- Some of bone marrow consists of yellow fat, called yellow marrow.

Bones

- The outer portion of bone marrow is comprised of red tissue, called red marrow.

- The red marrow is responsible for blood cell and platelet formation.

Bones

- Bone is a living tissue that changes constantly.

- Bone undergoes continuous deposition (creation of new bone material) and resorption (removal of old bone material).

Bones

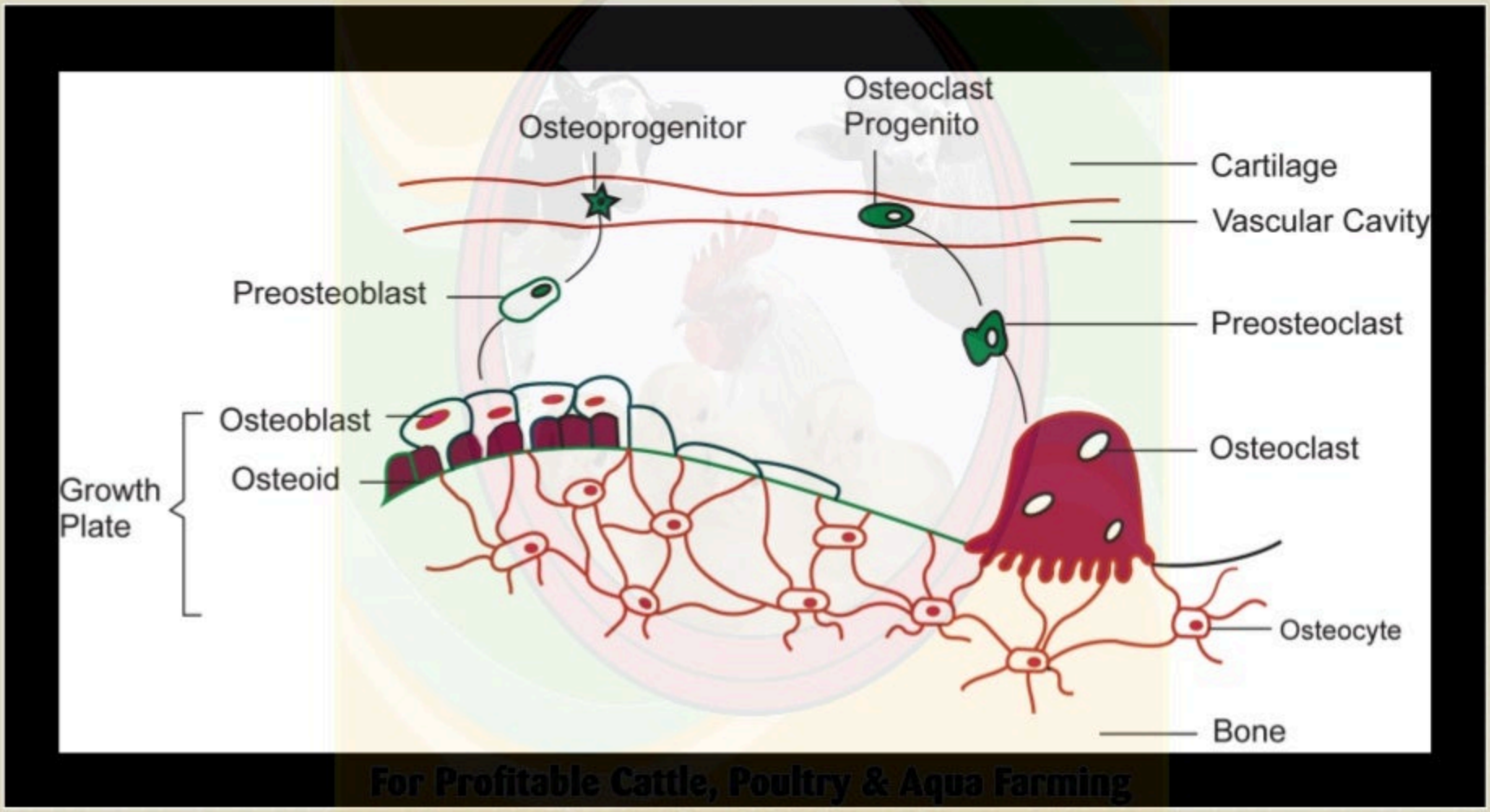
- Bone is formed from cartilage when the animal is an embryo. This process is known as endochondral ossification or endochondral bone formation.

Bones

- The bone forming cells are known as osteoblasts.

- Osteoblasts develop into osteocytes, or mature bone cells.

Formation of Bone Cells at a Growth Plate

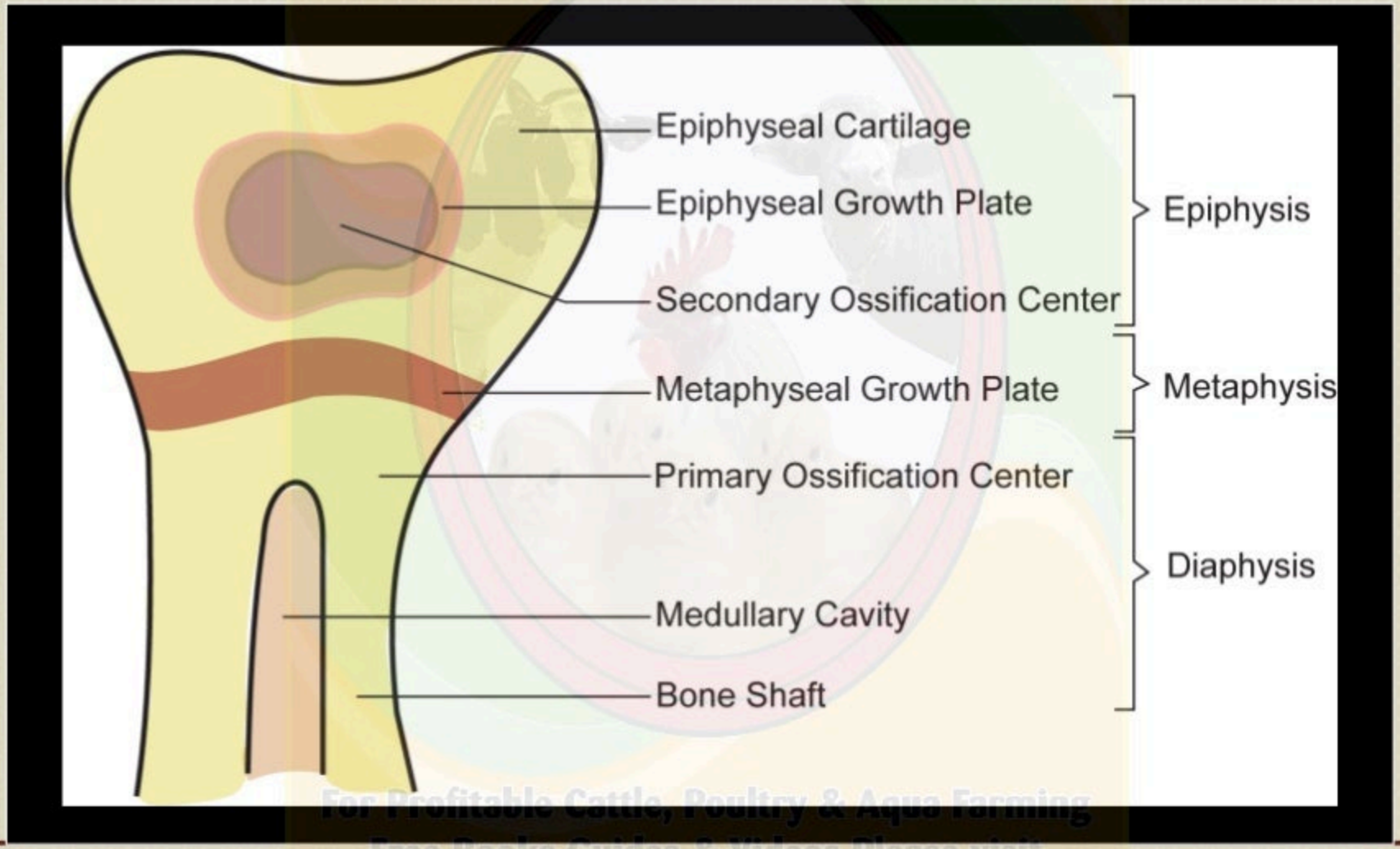


Bones

Bone formation occurs at a growth plate:

- Primary ossification occurs at the metaphyseal growth plate.
- Secondary ossification occurs at the epiphyseal growth plate. The secondary ossification site is in the center of the epiphysis.

Bone Formation in a Long Bone



Connective Tissue

Connective tissue binds tissues together to give form and strength to organs and provide protection and leverage.

Connective Tissue

Four types of connective tissues exist within the skeletal system:

- Ligaments
- Tendons
- Cartilage
- Fascia

Ligaments / Tendons

- Ligaments connect bone to bone
- Tendons attach muscle to bone

Cartilage

Three types of cartilage found in the body:

- Hyaline cartilage is found on the ends of bones and acts as cushioning in joints.
- Elastic cartilage makes up body parts such as the ears.
- Fibrocartilage provides cushioning between the inter vertebral discs.

Fascia

- Fascia is located between the skin and the underlying muscle or bone. It is comprised of two layers. The top layer, superficial fascia, is attached to the skin while the bottom layer, deep fascia, covers the muscle or bone.

Joints

Joints are articulations (unions) between bones. Three types of joints are found in the body:

- Fibrous
- Cartaginous
- Synovial

Joints

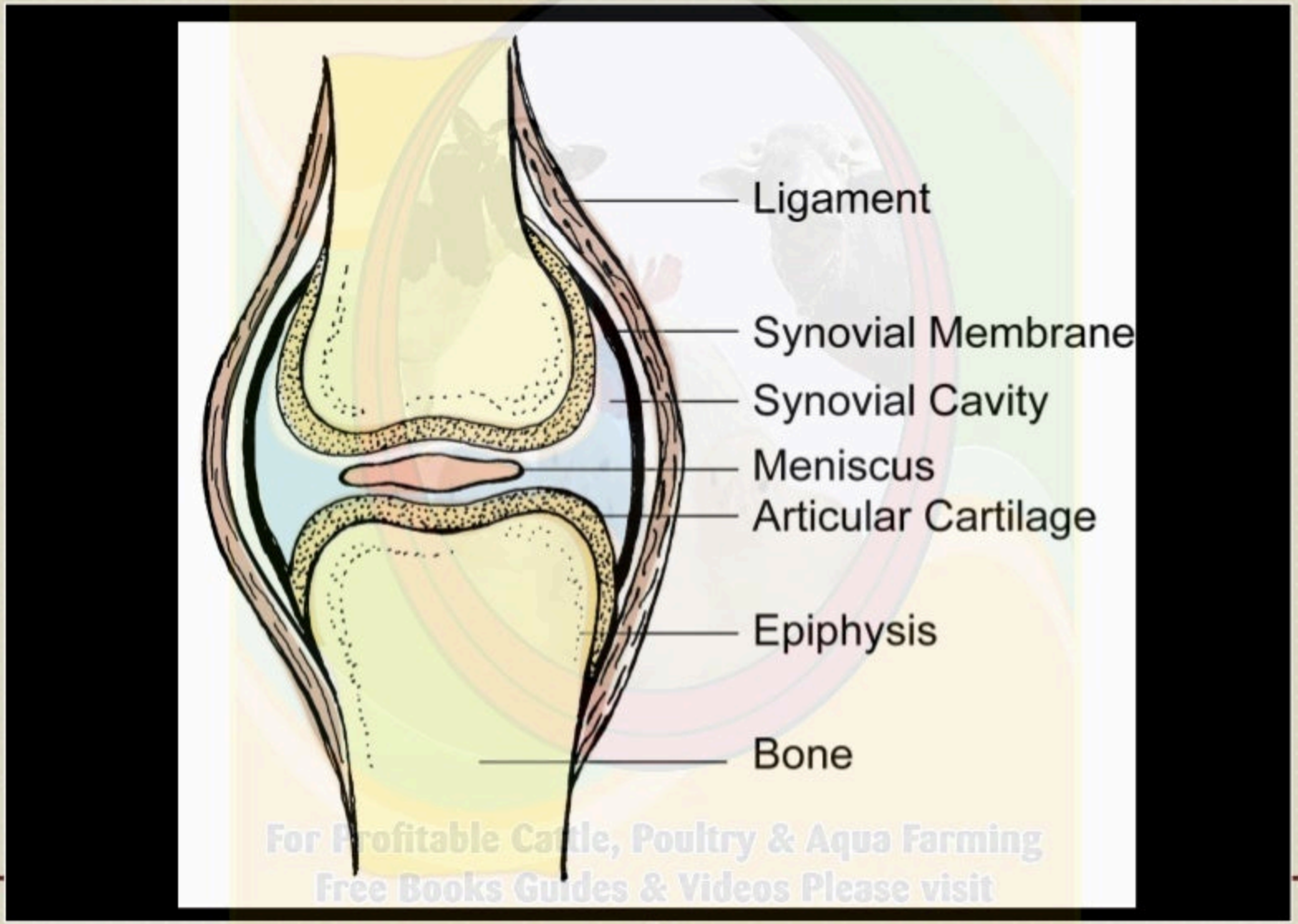
- Joints can be highly movable – for example, the shoulder
- Partially movable – for example, the ribs
- Immovable – for example, suture joints between the plates of the skull.

Synovial Joints

Allow the greatest range of movement such as:

- Gliding
- Flexion
- Extension
- Hyperextension
- Rotation
- Adduction
- Abduction
- Circumduction

Synovial Joint



Muscular System

Muscular System

- The muscular system, in conjunction with the skeletal system, allows the movement of internal structures, limbs, and the body as a whole.

Muscles

Muscles can be categorized by their:

- Function
  (skeletal, visceral, or cardiac)
- Activation method
  (voluntary or involuntary)
- Physiology
  (smooth, striated or unstrained)

Skeletal Muscles

- Skeletal muscles are striated, voluntary muscles that are involved in the movement of the skeleton.

- Skeletal muscles can be intentionally controlled by the animal.

Visceral Muscles

- Smooth or visceral muscles are involuntary, unstraited muscles found in the digestive organs and blood vessels of the body.

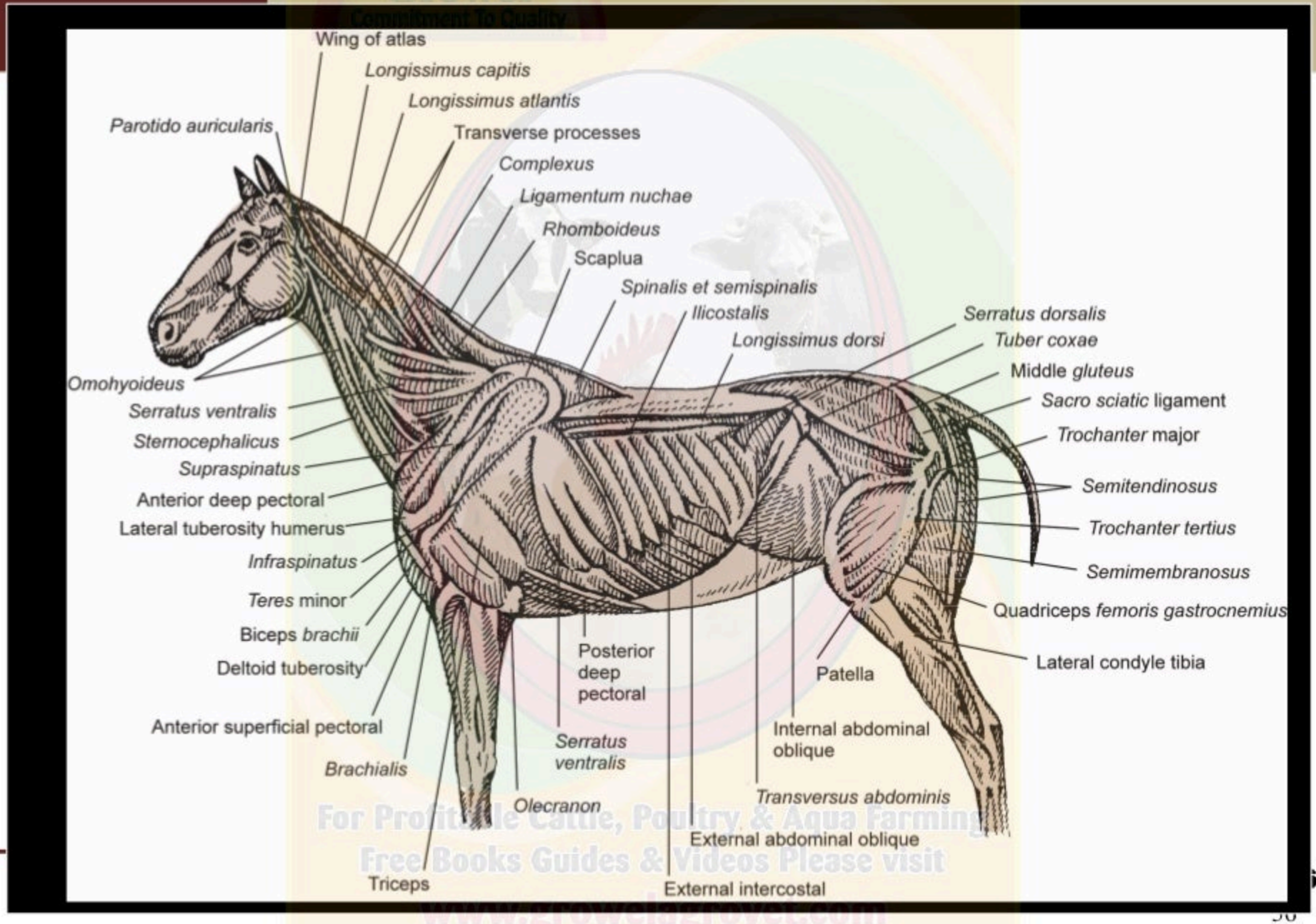
- Visceral muscles function automatically and can not be controlled by the animal.

Cardiac Muscles

- Cardiac muscle is involuntary, striated muscle found only in the heart.

- No conscious control of cardiac muscle occurs in the animal, but it can be regulated by the autonomic nervous system.

Superficial Muscles of a Horse



Movement

Skeletal muscles can be divided into four functional groups:

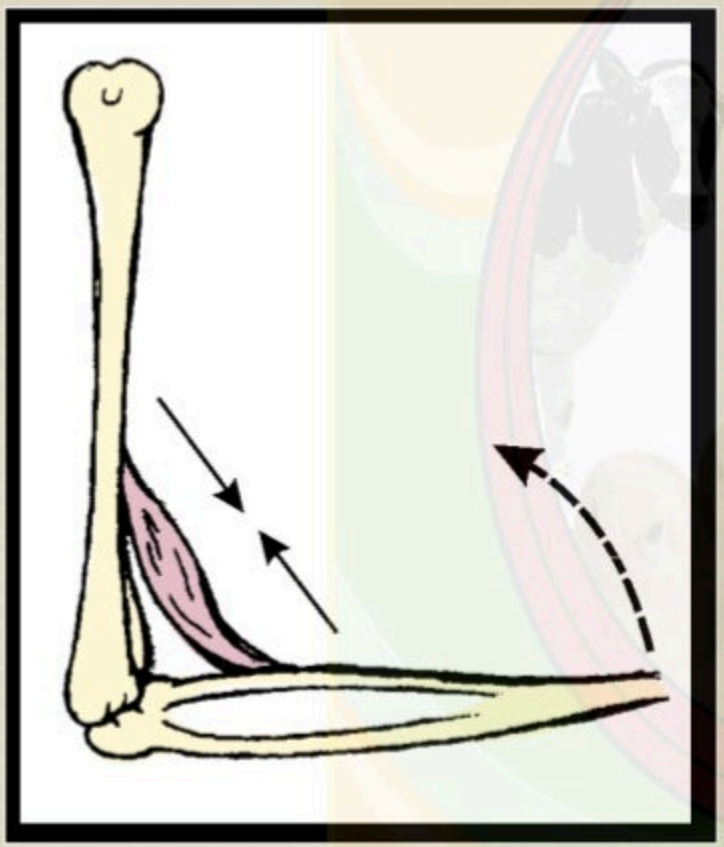
- Flexors
- Extensors
- Abductors
- Adductors

Movement

- Many muscles work in pairs so that when one contracts (flexes or shortens) the other one relaxes (extends or lengthens). This relationship is know as antagonism.

- Muscles that work together to perform a movement are referred to as synergists.

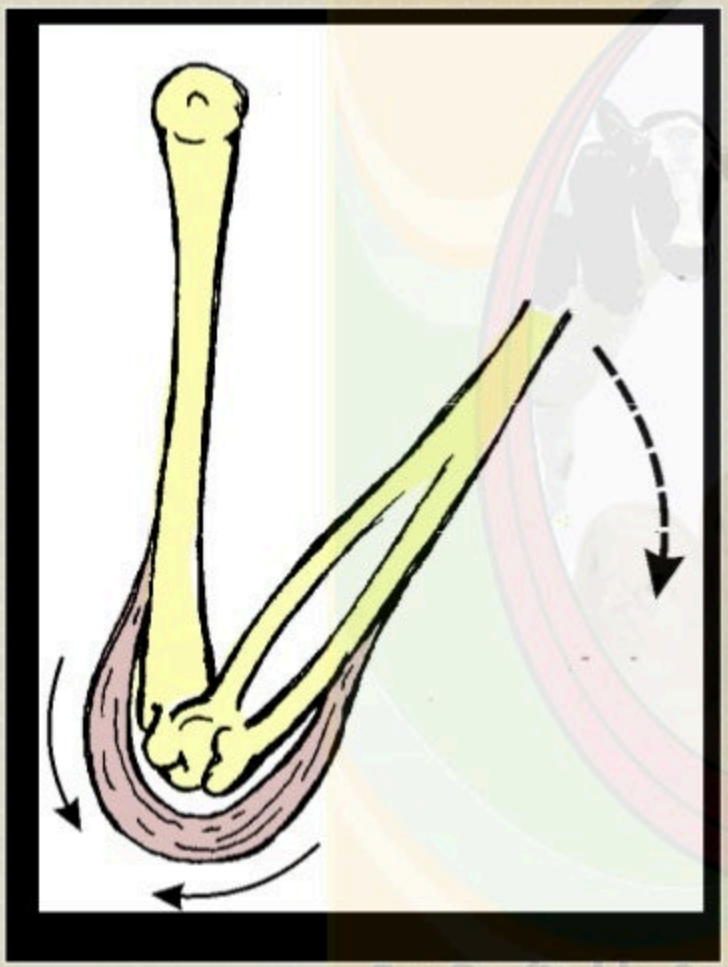
Movement



- Flexor muscles decrease the angle between two lever bones when they contract.

  Example: Biceps

Movement



- Extensor muscles increase the angle between two lever (bones) when they contract.

Example: Triceps

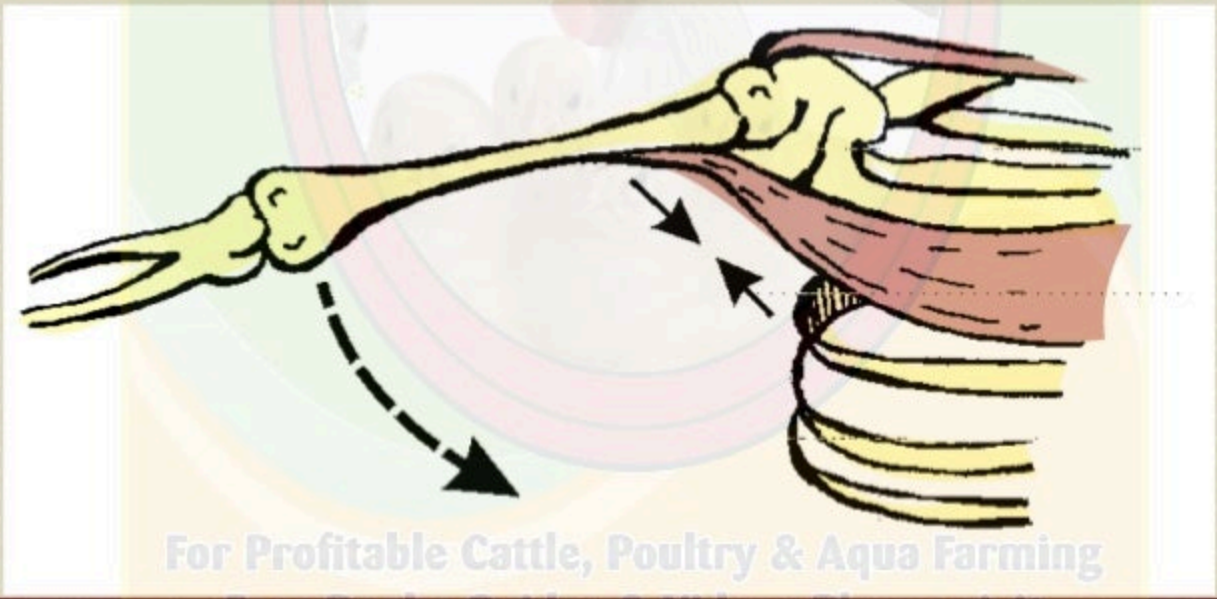
Movement

- Abductor muscles move limbs away from the median plane (the middle
or main part of the body).

Example: Deltoids

Movement

- Adductor muscles pull limbs toward the median plane (middle or main part of the body).
  Example: Pectoralis Major



Attachment

- Most skeletal muscles attach to two different bones.

- The point of origin is on the most stable or least movable bone while the insertion point is on the more movable bone.

Structure of Skeletal Muscle

- Skeletal muscle is made up of bundles of fibers or cells that stretch from one tendon, or connective tissue, to the other tendon.

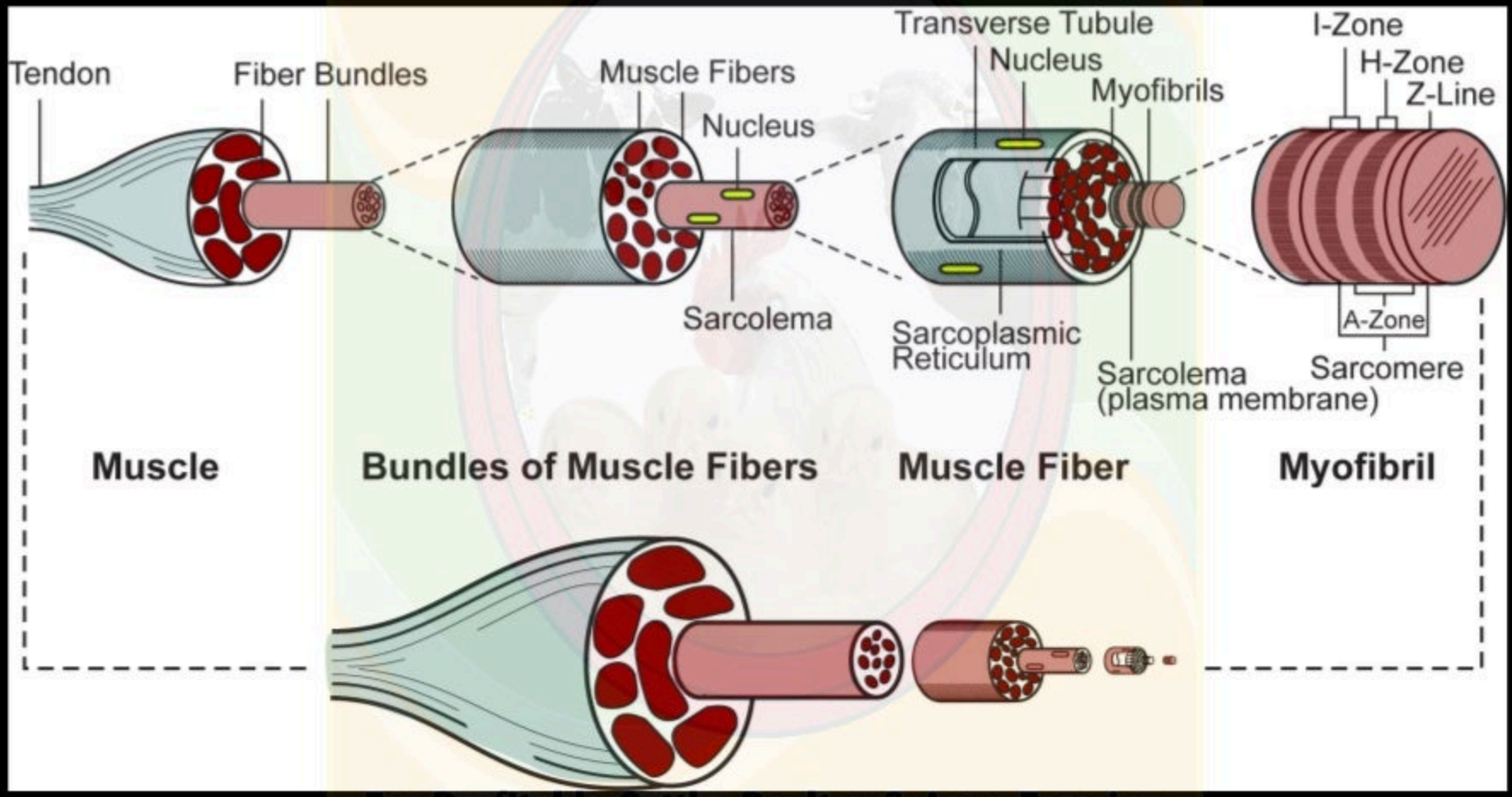
- These bundles of fibers lie parallel to each other within the muscle sheath making the muscle appear striped, or striated.

Structure of Skeletal Muscle

- Each bundle consists of fibers, which are individual cells with multiple nuclei.

- Individual muscle fibers are made up of bundles of myofibrils enclosed in a series of sarcomeres. They are made up of thick filaments of myosin and thin filaments of actin.

Structure of Skeletal Muscles



Contraction

- Muscle contraction occurs as a result of a process known as sliding-filament action.

- Each individual sarcomere contracts as a result of the actin and myosin filaments sliding over each other.

Muscle Contraction

- Energy utilized for muscle contraction comes primarily from non-protein sources such as adenosine triphosphate (ATP), glycogen and body fats.

Circulatory System

Circulatory System

The circulatory system includes the heart, veins, capillaries, arteries, lymph vessels, and lymph glands. The circulatory system is responsible for:

- Distributing blood throughout the body
- Removing wastes
- Mounting immune responses to infection
- Aiding in regulating body temperature

Blood

- Blood provides organs, tissues and cells with oxygen, nutrients, gasses, hormones, and antibodies, and removes carbon dioxide and metabolic wastes.

Lymphatic System

- The lymphatic system is responsible for draining fluid from the body and is an important defense mechanism against infection.

Heart

- The heart is a muscle and is divided into the left and right side. Each side is made up of an atrium and a ventricle.

- The atria receive blood, either from the lungs or the rest of the body.

Heart

- Blood then passes into the ventricle before being pumped out of the heart again.

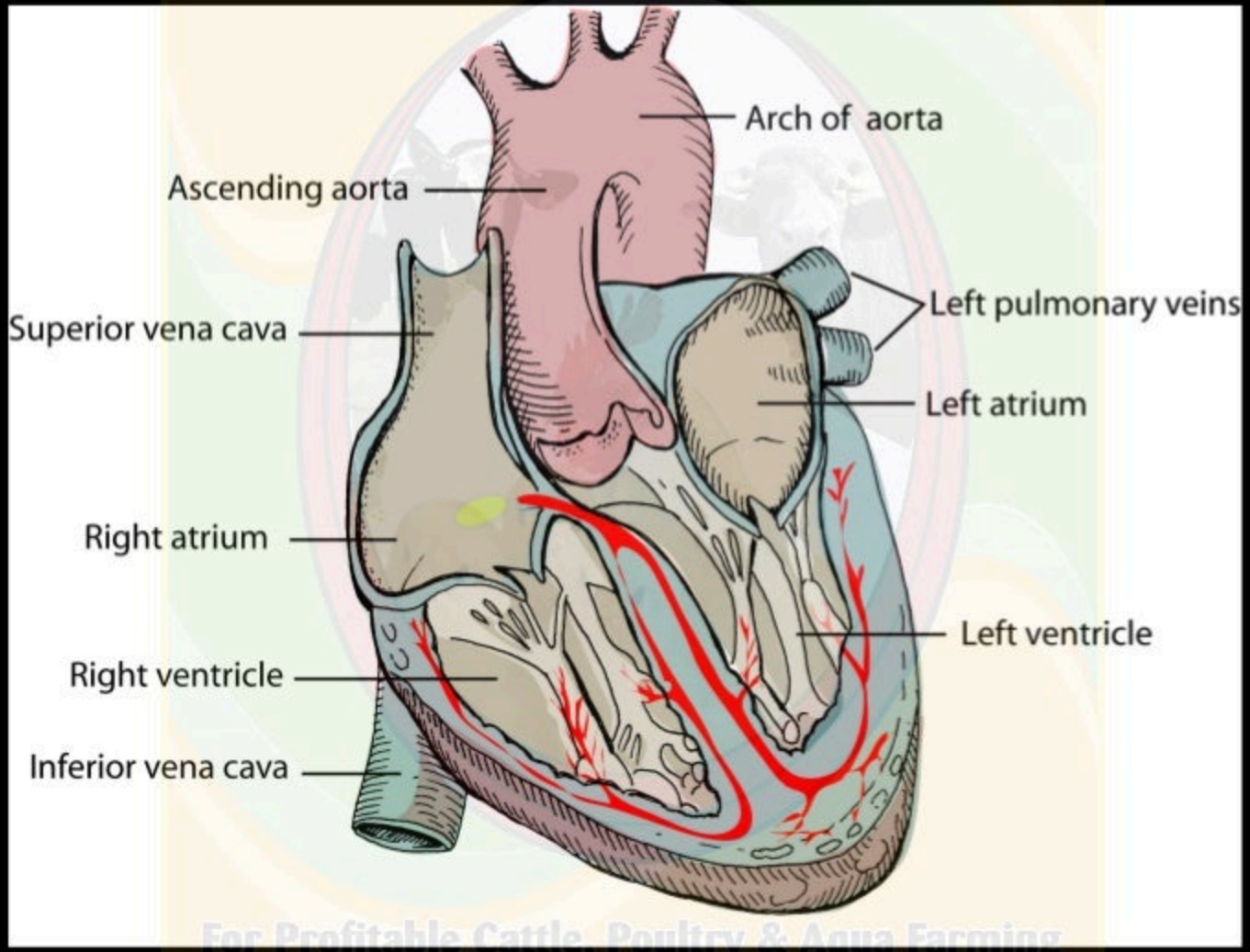
- Deoxygenated or venous blood coming from the body enters the right atrium, passes through the right V.A. (atrioventricular) valve and into the right ventricle.

Heart

- It is then pumped through the pulmonary artery to the lungs.

- Oxygenated or arterial blood returns from the lungs via the pulmonary vein and enters the left atrium; it then passes through the left A.V. valve and into the left ventricle before being pumped out of the heart to the rest of the body via the aorta.

Heart



Blood Vessels

Five types of blood vessels exist within the body:

- Arteries
- Arterioles
- Veins
- Venules
- Capillaries

Blood Vessels

- Arteries are blood vessels that carry blood away from the heart.

- Arterioles are small arterial branches that deliver blood to capillaries.

Blood Vessels

- Veins are blood vessels that convey blood from tissues back to the heart.

- Venules are small veins that collect blood from capillaries and delivers it to a vein.

Blood Vessels

- Blood vessels gradually become smaller as they migrate away from the heart.

- Arteries divide into arterioles and veins divide into venules.

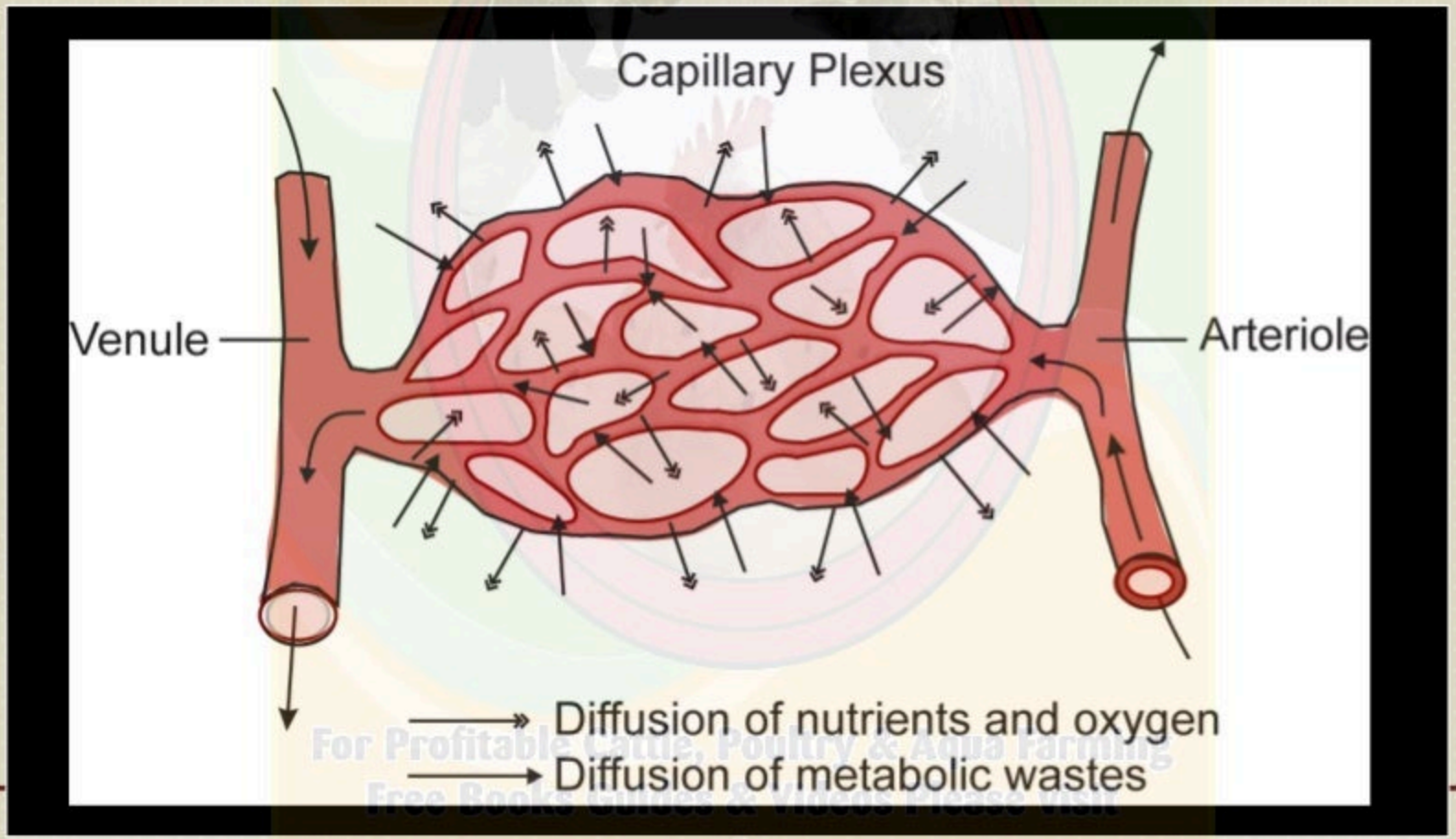
Capillaries

- Capillaries are the smallest blood vessels. Capillaries are involved in the transfer of oxygen, nutrients and gases to the cells of the body and the removal of carbon dioxide and metabolic waste.

- Capillaries have very thin membranes, so the components of blood can diffuse across the membrane and enter cells.

Capillaries

- Interaction of molecules flowing in and out of blood at the capillary bed.



Circulation Systems

The two main circulation systems within the body are the:

- Pulmonary System
- Systemic System

Circulation System

- The pulmonary system delivers blood to and from the lungs.

- The systemic system circulates blood throughout the rest of the body.

Composition of Blood

Blood is composed of:

- Red cells (erythrocytes),
- White blood cells (leukocytes)
- Platelets (thrombocytes)
- Plasma

Blood

- Red blood cells are the most numerous and contain a protein called hemoglobin.

- Hemoglobin contains the mineral iron and is responsible for carry oxygen in the blood.

- Red blood cells deliver oxygen to cells and aid in the removal of carbon dioxide.

Blood

- White blood cells are responsible for the body's immune response, or defense against infection.

- There are two types of white blood cells, granulocytes and agranulocytes (lymphoid cells) which aid in combating foreign bodies, bacteria, viruses and other infective agents.

Blood

- Platelet (thrombocyte) is a fragment of cytoplasm enclosed in a cell membrane and lacking a nucleus; found in circulating blood, platelets play a role in clotting.

- Plasma is the yellowish extracellular fluid found in blood vessels. Plasma is 90% water.

Lymphatic System

- They lymphatic system is comprised of lymph vessels, lymph nodes, lymph organs and areas of lymph tissue within the intestinal wall.

- Lymphatic organs include bone, marrow, tonsils, thymus, and the spleen.

Lymphatic System

- The lymphatic system maintains internal fluid balance and is an important component of the body's immune system.

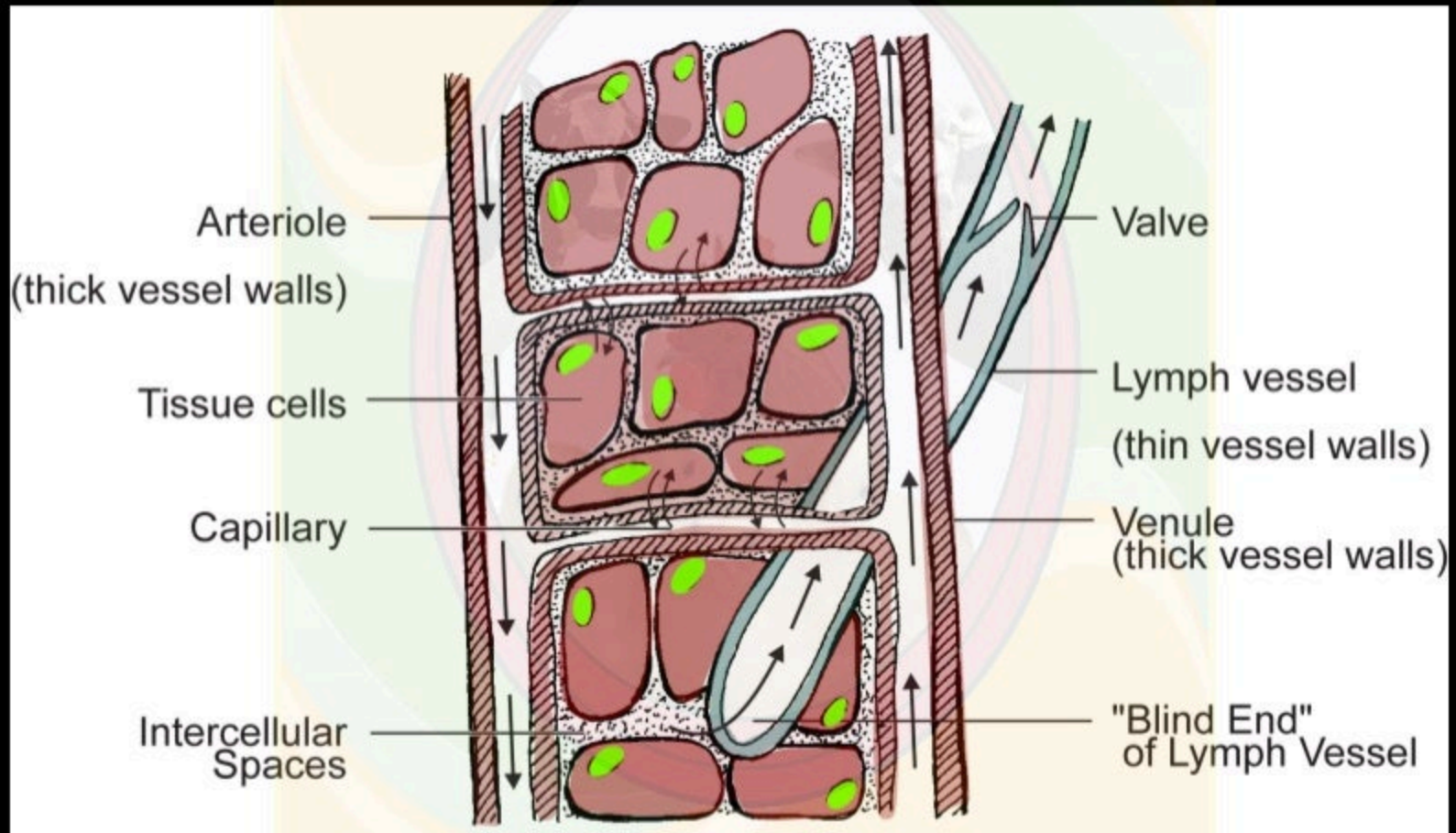
- Lymph vessels are thin-walled and blind-ended. They originate in the body tissue and take lymph towards the heart.

Lymphatic System

- Lymph nodes are located throughout the body along the lymph vessels.

- Lymph nodes filter lymph and act as a barrier against infection by harboring lymphocytes, monocytes and plasma cells.

Lymphatic System



Digestive System

Digestive System

The digestive system is made up of:

- Mouth
- Tongue
- Pharynx
- Esophagus
- Stomach (or stomachs)
- Small intestine
- Large intestine
- Anus

Digestive System

- The digestive system breaks down various nutrients found in feed into molecules that can be used by the cells of the body.

Digestive System

Stages of the digestive process include:

- Biting
- Chewing
- Swallowing and mixing of food
- Digestion and absorption of nutrients
- Excretion of waste

Digestive System

- Digestion is the chemical breakdown of complex food into simple nutrients and ultimately into molecules that are small enough to pass across the wall of the intestines.

- The passage of molecules across the intestinal wall in to the blood or lymph system is called absorption.

Digestive System

- Animals such as cattle, sheep, horses, and rabbits, which depend entirely on plants for food are called herbivores.

- Other species, such as dogs and cats, which depend almost entirely on the flesh of other animals for food, are called carnivores.

Digestive System

- Species such as swine, poultry, and humans, which consume both flesh and plants, are called omnivores.

- Different species of animals have digestive tracts adapted to the most efficient use of the feed they consume.

Digestive System

- Food must be broken down chemically into molecules before it can enter the blood stream of an animal and be used by its cells.

Digestive System

Most food that is eaten by animals can be broken down into:

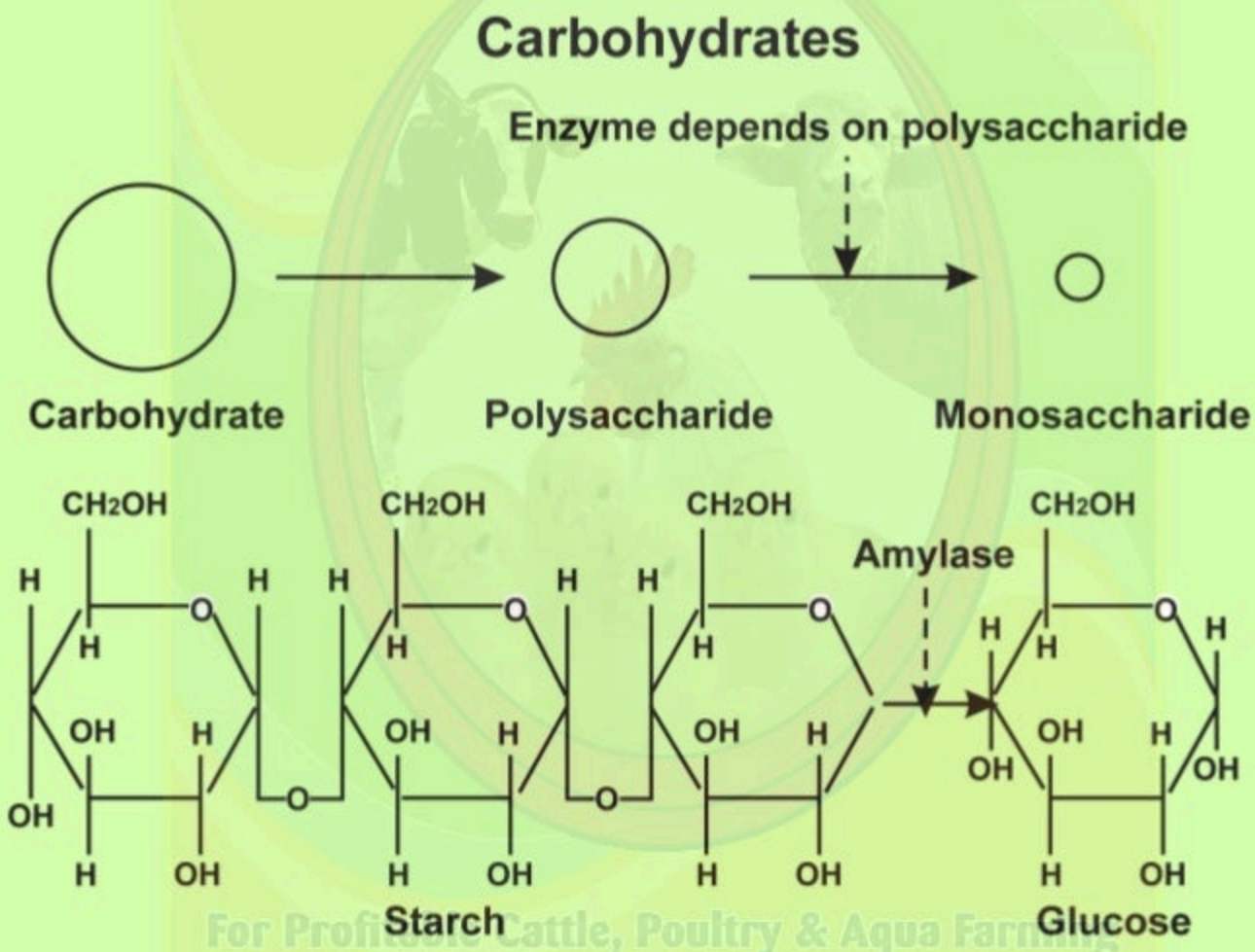
- Carbohydrates
- Proteins
- Lipids
- Vitamins and minerals

Carbohydrates

- Carbohydrates are polysaccharides, which are made up of multiple monosaccharides.

- Polysaccharides include, starch, cellulose, hemicellulose, and glycogen.

Carbohydrates



Digestive System

- Starch is made up of multiple glucose molecules; therefore glucose is a monosaccharide.

- Enzymes that hydrolyze polysaccharides are named after the specific polysaccharide that they break down.

Digestive System

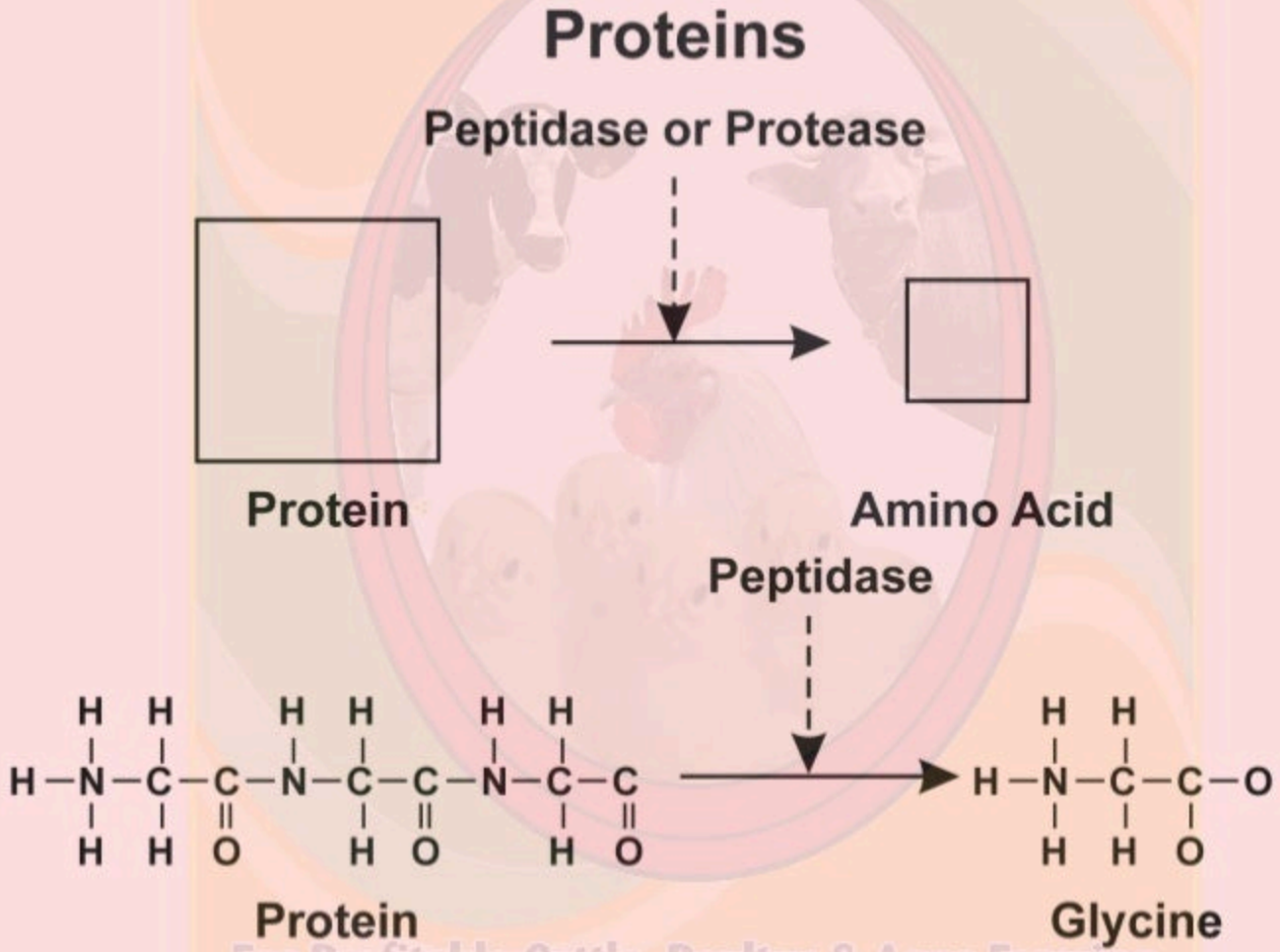
- Starch is broken down by amylase, cellulose is broken down by cullulase and sucrose is broken down by sucrase.

- The suffix "ase" indicates that the compound is an enzyme.

Proteins

- To maintain metabolic function, animals must obtain amino acids from their diet to be able to synthesize protein.
- Proteins are broken down into amino acids by enzymes called proteases and peptidases.
- Proteases break down large protein molecules and peptidases break down small protein molecules.

Proteins



Lipids

Lipids (fats) fall into three categories:

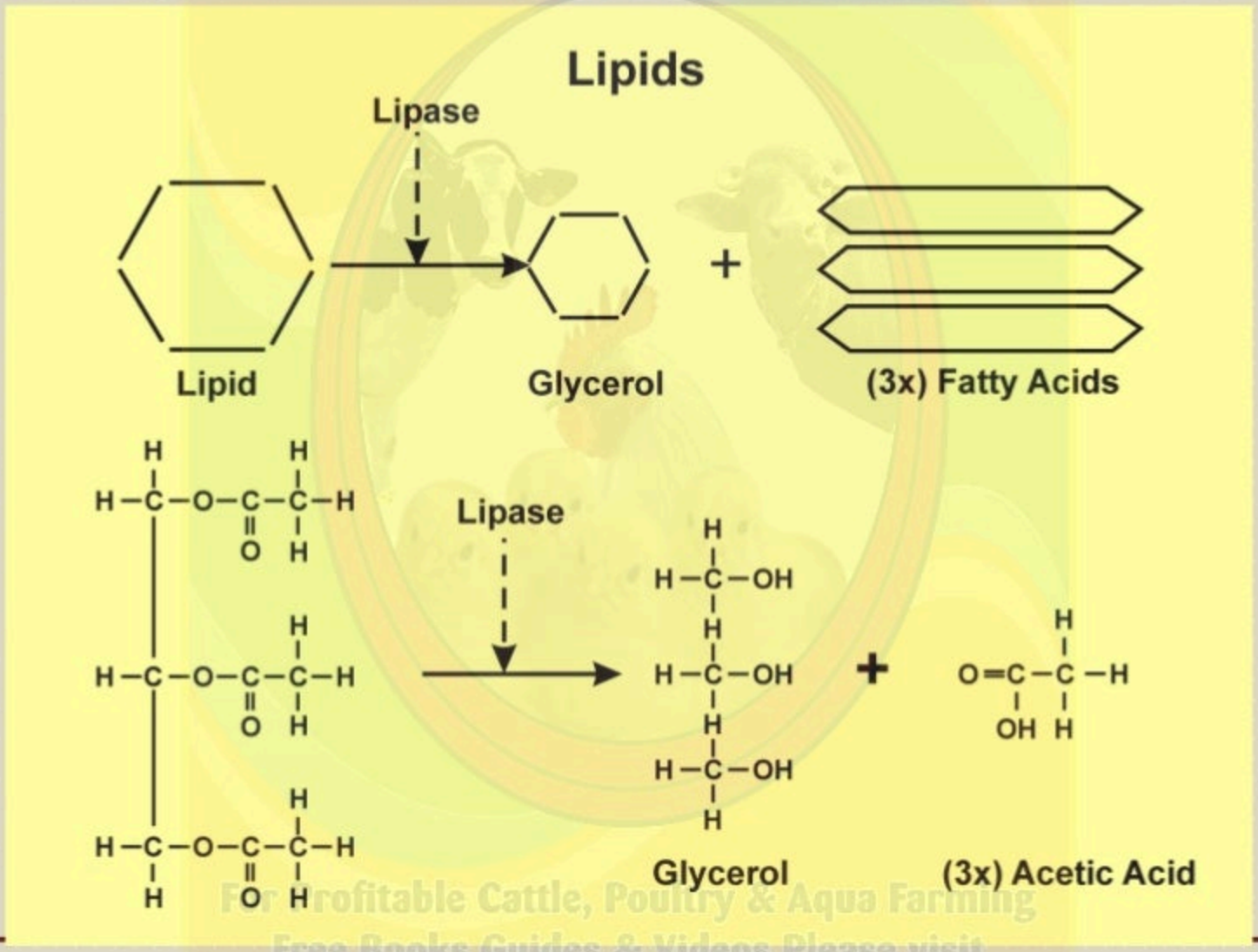
- Triglycerides
- Phospholipids
- Waxes

Triglycerides

- Triglycerides are made up of glycerol molecule and three fatty acid molecules.

- Enzymes called lipases break down triglycerides.

Lipids



Digestive System

Animals can be divided into three groups based on their digestive systems:

- Ruminants
- Monogastrics
- Hindgut

Ruminants

Sheep, cattle, goats, and deer are ruminant animals. They have four stomachs instead of one.

The four stomachs are:

- Rumen
- Reticulum
- Abomasum
- Omasum

Rumen

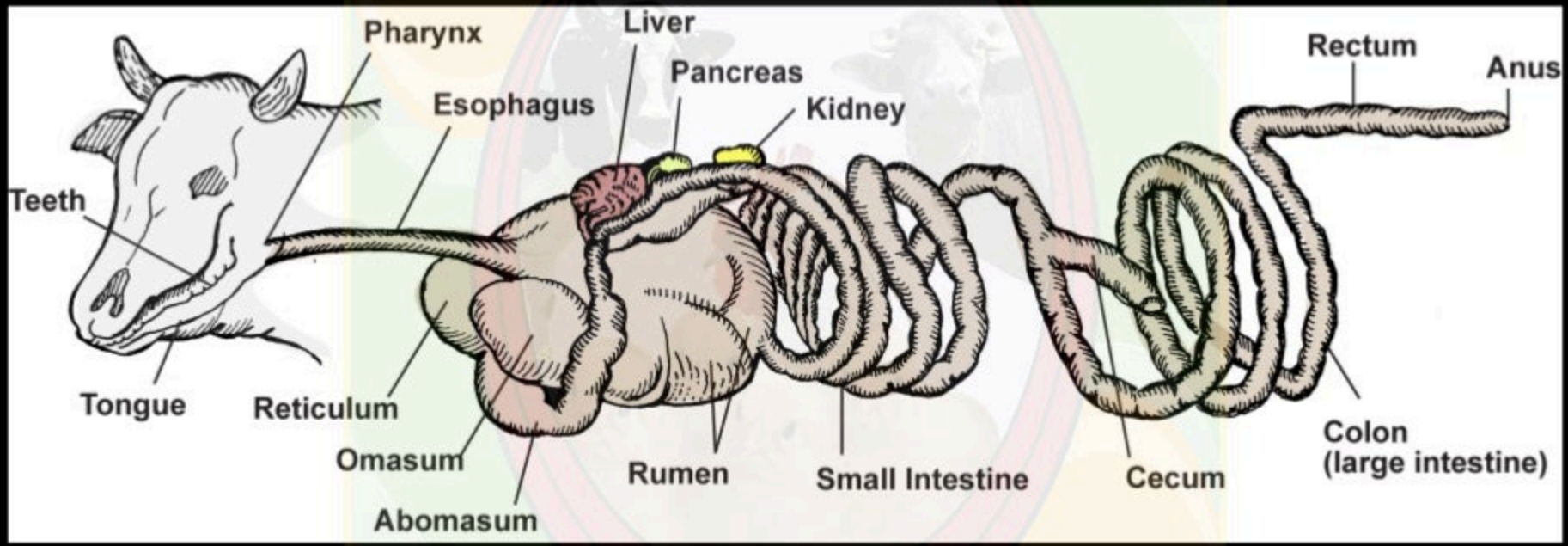
- The largest chamber of the of the ruminant stomach
- Contains millions of microbes, bacteria, and protozoa
- Lining composed of many papillae that aid in the absorption of nutrients
- Produces a large amount of methane gas, mainly methane and carbon dioxide

Rumen

- When an animal eats, these microbes, bacteria, and protozoa digest the food as it enters the rumen.

- Nutrients are then released to be used by the ruminant animal.

Digestive System (Cow)

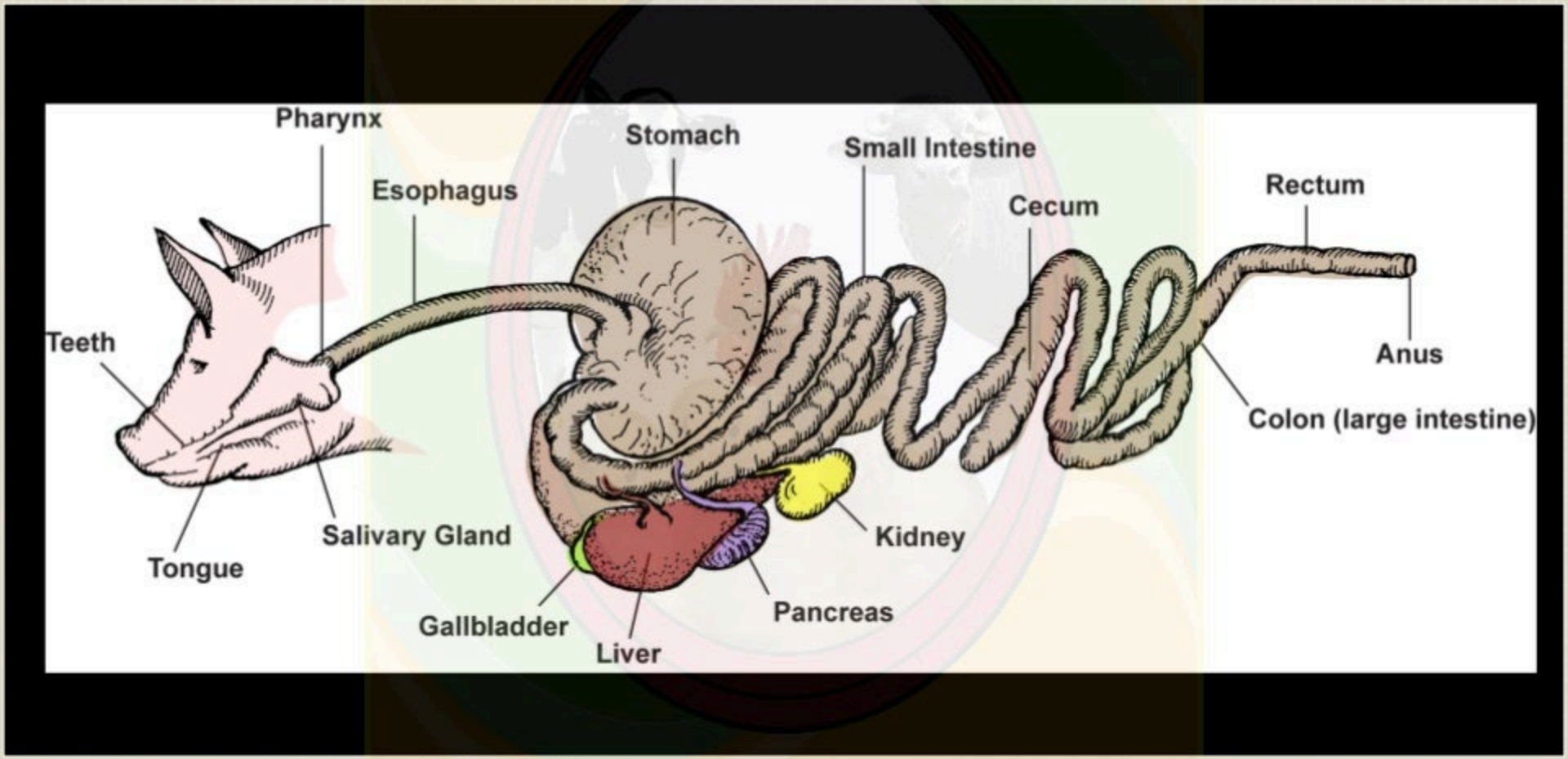


Monogastrics

- Swine and poultry are monogastric animals, which means they have a single glandular stomach.

- Swine have a digestive system that is anatomically and physiologically similar to the human digestive system.

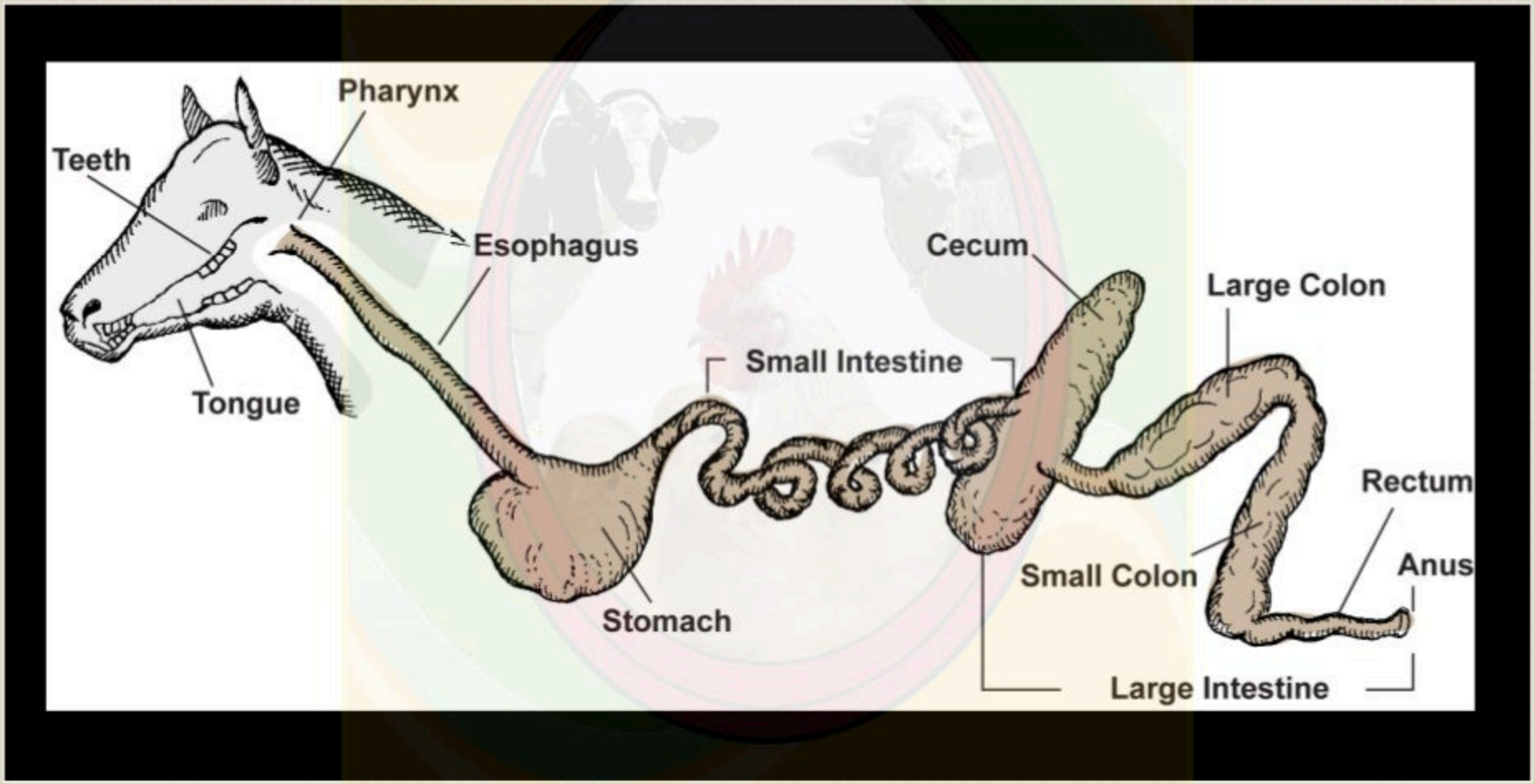
Digestive System (Pig)



Hindgut

- Horses, donkeys, and rabbits are examples of hindgut fermenters.
- Hindgut fermemeters have a larger than normal cecum or hindgut.
- These animal require microbes to break down cellulose so that they can digest high-fiber plant material such as grass.

Digestive System (Horse)



Digestive System

The digestive system is made up of:

- Mouth
- Esophagus
- Non-ruminant Stomach
- Ruminant Stomach
- Small intestine
- Large intestine
- Accessory digestive organs

Mouth

- The tongue and lips are used to select food that that animal intends to ingest.

- Food is chewed or physically broken down to smaller pieces by a process called mastication.

Mouth

Saliva provides:

- Lubrication so the food may be swallowed
- Enzymes that break down the nutrients

Food moves down the esophagus to the stomach in a wave-like motion called peristalsis.

Esophagus

- The esophagus is a tube-like tract that connects the pharynx to the stomach.

- When an animal swallows, the larynx rises so that the epiglottis closes off the trachea, thus preventing food from entering the air passageway.

Non-ruminant Stomach

- The non-ruminant stomach is a storage chamber that holds food particles.

- The breakdown of food particles by enzymes continues in the stomach.

Ruminant Stomach

- Food particles enter the rumen and microbes start eating or digesting these particles.

- The microbes produce waste or by-products which can then be used by the animal. Some of the microbes pass into the intestines where they are digested by the animal.

- Ruminants get their main source of protein (approximately 70%) from digesting the microbes that pass into the small intestine.

Ruminant Stomach

- All ruminants are herbivores. They consume grasses and other plant materials containing larges amount of cellulose.

- Microorganisms in the digestive system of ruminants synthesize all amino acids essential to the animal.

Ruminant Stomach

- Methane and carbon dioxide gas is expelled by belching and, to a lesser extent, absorbed into the blood.

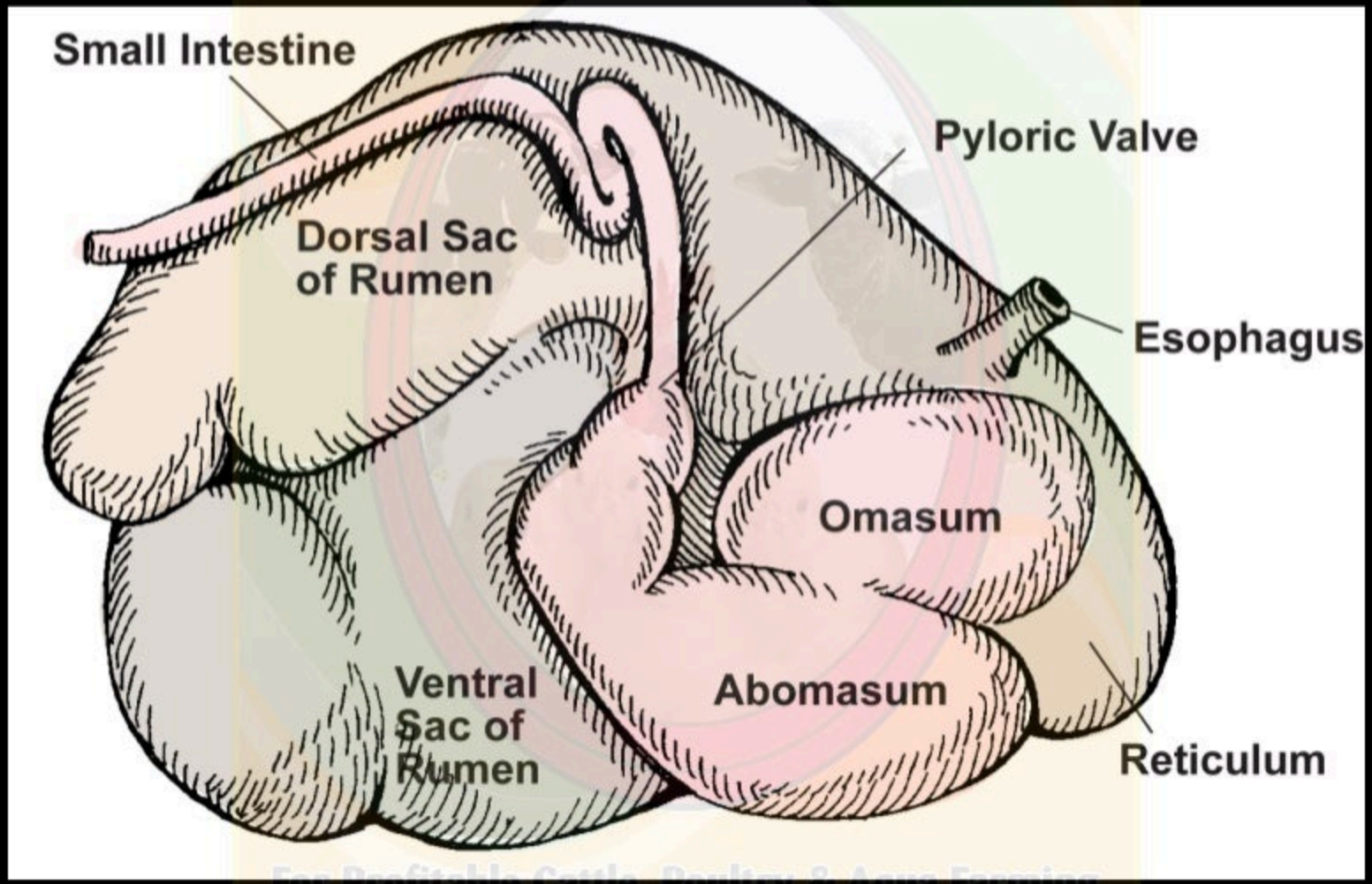
- If the gases are allowed to accumulate in the rumen, they may cause bloat (an abnormal inflation or distension of the rumen).

Ruminant Stomach

- Ruminants chew food, then swallow it and start to digest it.

- They are then able to regurgitate the food and remasticate it (chew it more). This function helps to break down the fibrous material further and allows the microbes the access food particles.

Ruminant Stomach



Small Intestine

Absorption is the main function of the small intestine. The small intestine includes:

- Duodenum
- Jejunum
- Ileum

The inside the small intestine is covered by villi, highly vasculated, finger-like projections that greatly increase the absorptive surface area.

Large Intestine

The large intestine consists of:

- Cecum
- Ascending colon
- Transverse colon
- Descending colon
- Sigmoid colon

Large Intestine

- The large intestine removes water and prepares the dry waste matter for feces and finally defecation.

- Fecal material is excreted via the rectum. It passes through the rectum and then exits the body through the anus.

Accessory Digestive Organs

Accessory digestive organs are associated with the digestive system:

- Salivary glands
- Pancreas
- Liver
- Gallbladder

Salivary Glands

- Salvia has pH balancing properties and provides enzymes that begin the chemical breakdown of nutrients.

Pancreas

The pancreas is made up of an endocrine and exocrine gland.

- The endocrine gland produces insulin.
- The exocrine gland produces enzymes.

Liver

- Molecules in the liver are converted to compounds that animals need for tissue growth, nerve formation, enzyme synthesis, and many other functions.

- The liver also excretes bile, which is stored in the gallbladder.

Gallbladder

- The gallbladder is where bile is stored.

- Bile has properties that allow it to emulsify fats, increasing the efficiency at which they are digested.

Digestive System (Poultry)

- Poultry do not have teeth to physically break down their food. The glandular stomach of poultry is called proventriculus.

- Before reaching the proventriculus, food is stored in an enlargement of the gullet, called the crop, where it is softened.

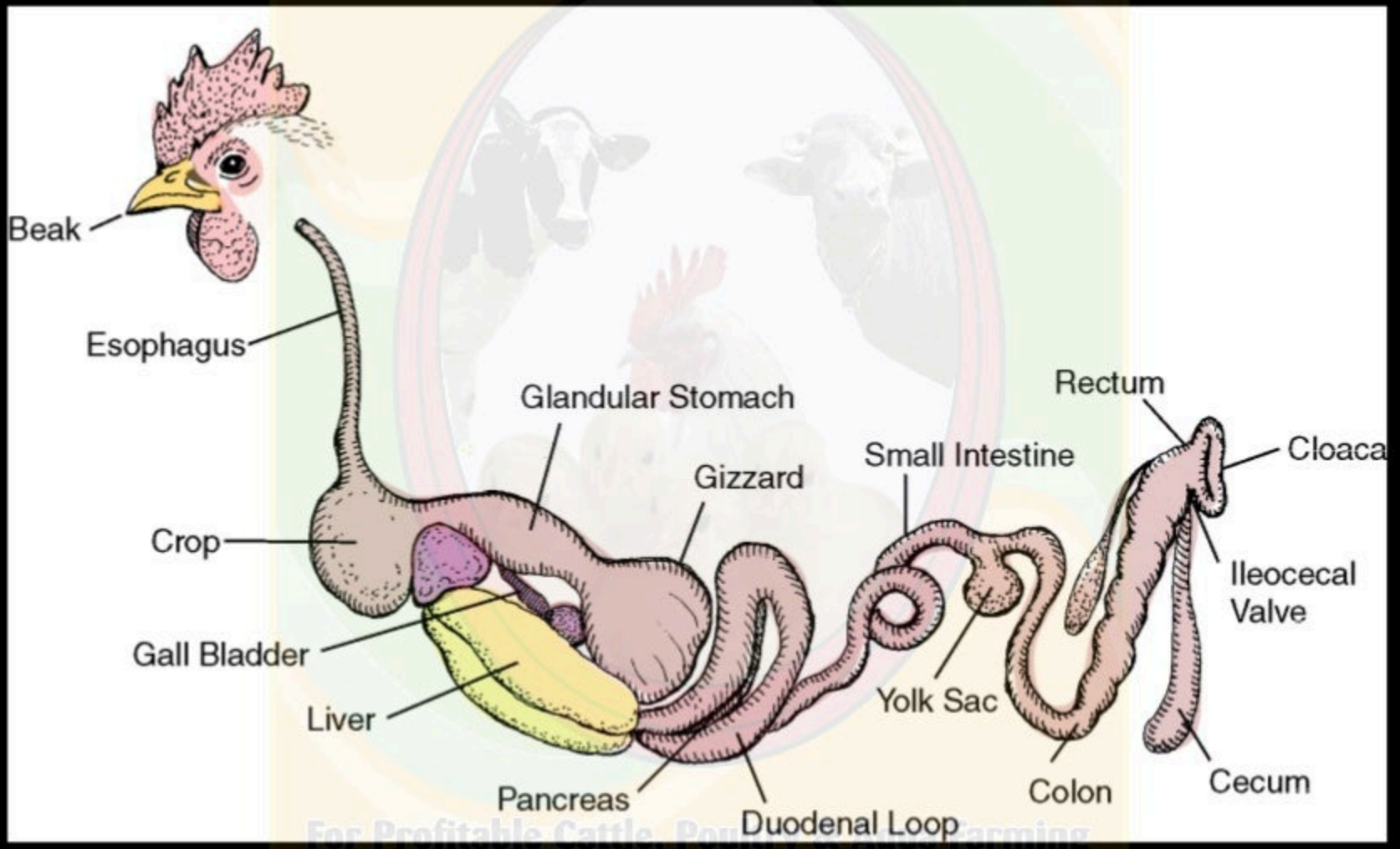
Digestive System (Poultry)

- Feed passes from the proventriculus to the ventriculus, or gizzard, which crushes and grinds coarse feed.

Digestive System (Poultry)

- Feed passes from the gizzard into the duodenum.
- Pancreatic juices are secreted containing enzymes that aid in the digestion of carbohydrates, lipids, and proteins.
- Liver bile, which is also secreted into the duodenum, aids in the digestion of lipids.
- Absorption takes place in the small intestine.

Digestive System (Poultry)



Respiratory System

Respiratory System

- Provides oxygen to the blood.
- Excretes waste gases such as carbon dioxide.
- Creates noise via the voice box (in most animals) or the syrinx (in birds)

Respiratory System

The respiratory system includes:

- Lungs
- Nostrils
- Nasal cavity
- Pharynx
- Larynx
- Trachea

Respiratory System

- Nostrils are the external openings of the respiratory tract that lead to the nasal cavity.
- Air and food pass through the pharynx, but not at the same time.
- The Larynx controls breathing and prevents the inhalation of foreign objects into the lungs.

Trachea

- The trachea (windpipe) contains rings of cartilage that are rigid and prevent it from collapsing.

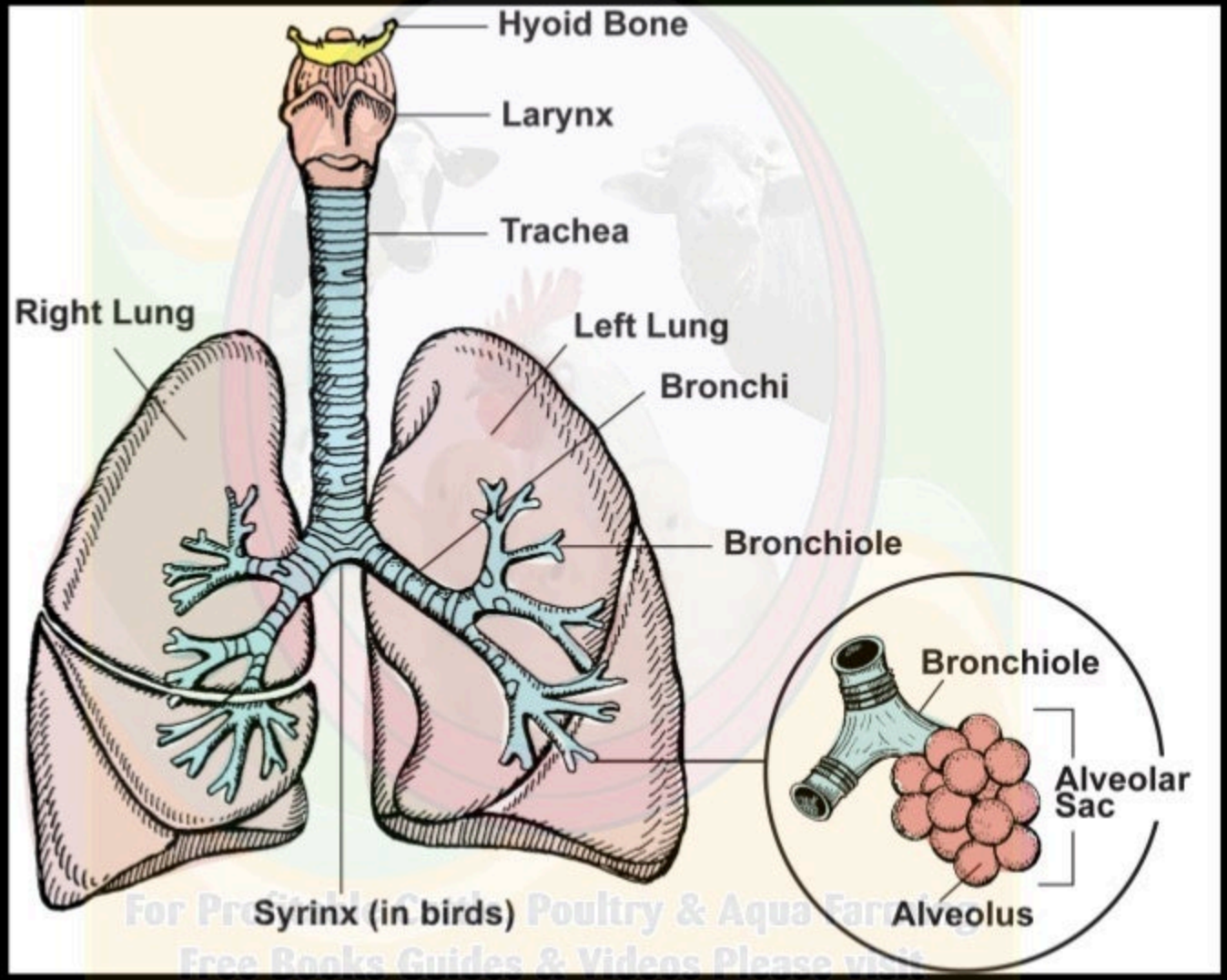
- The trachea enters the chest cavity as a single tube to the base of the heart where it divides into to two braches called primary bronchi.

Bronchi / Lungs

- Each bronchi passes into one of the lungs.

- Inside the lungs, the bronchi branch into smaller bronchi and finally into very small tubes called bronchioles.

Respiratory System



Respiratory System

- The bronchioles open into alveolar ducts, which lead to the smallest portions of the respiratory system called alveoli.

- Oxygen is diffused from the bloodstream into the alveoli so it can be exhaled out of the body.

Lungs

The primary function of the lungs is to exchange gases with the atmosphere.

- Gas absorbed by the lungs during inhalation is oxygen.
- Gas exhaled is carbon dioxide.

Inhalation

- Muscles of the diaphragm contract causing the thoracic cavity to enlarge and a vacuum to be created. The lungs to expand and air is drawn into them.

Exhalation

- The diaphragm muscles relax, causing contraction of the chest muscles, which decreases the thoracic cavity size, resulting in the retraction of alveolar elastic fibers.

Breathing Rates

- Breathing rates of animals are controlled by nerve cells in a portion of the brain called the medulla oblongata.

- The rate at which the brain stimulates breathing is affected by the carbon dioxide content of the blood, body temperature, and messages from other parts of the brain.

Nervous System

Nervous System (Parts)

The nervous system is composed to two major parts.

- The central nervous system includes the brain and spinal cord.
- The peripheral nervous system includes nerves found in all other regions of the body.

Nervous System (Function)

Functions of the nervous system include:

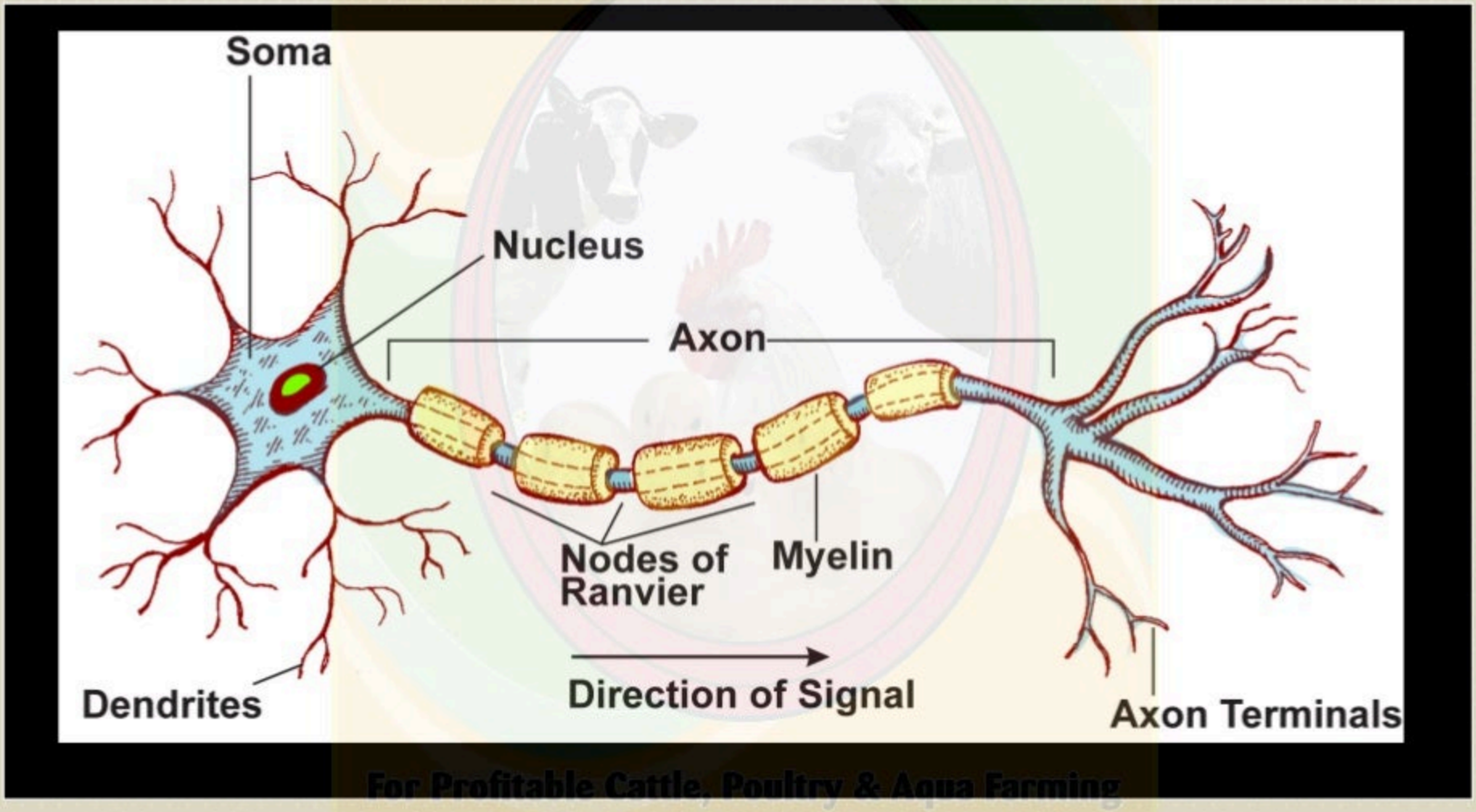
- Coordinating physical movement of the body.
- Responding to the action of all the senses; hearing, sight, smell, taste, and touch.

Nervous System

Nerve cells or neurons, consist of:

- A single long fiber (axon)
- Several branched threads (dendrites)

Nervous System



Nervous System

- Dendrites receive messages from other nerves or organs.

- An electrical impulse passes along the axon and is then conducted (passed on) to another dendrite or to an effector organ, such as a muscle, which is stimulated to move or react.

Nervous System

- The space between the axon terminals of one neuron and subsequent dendrites of the next neuron is a synapse.

- Before an impulse can reach the brain, it must travel along a series of neurons and synapses. Some impulses are sent directly to an effector organ.

Nervous System

- Nerves occur as single neurons or in bundles, called nerve trunks.

- Ganglions are the nerve bundles that occur outside of the brain and spinal cord.

Nervous System

- Nerves that receive stimuli and carry them to the central nervous system are known as the sensory or afferent neurons.

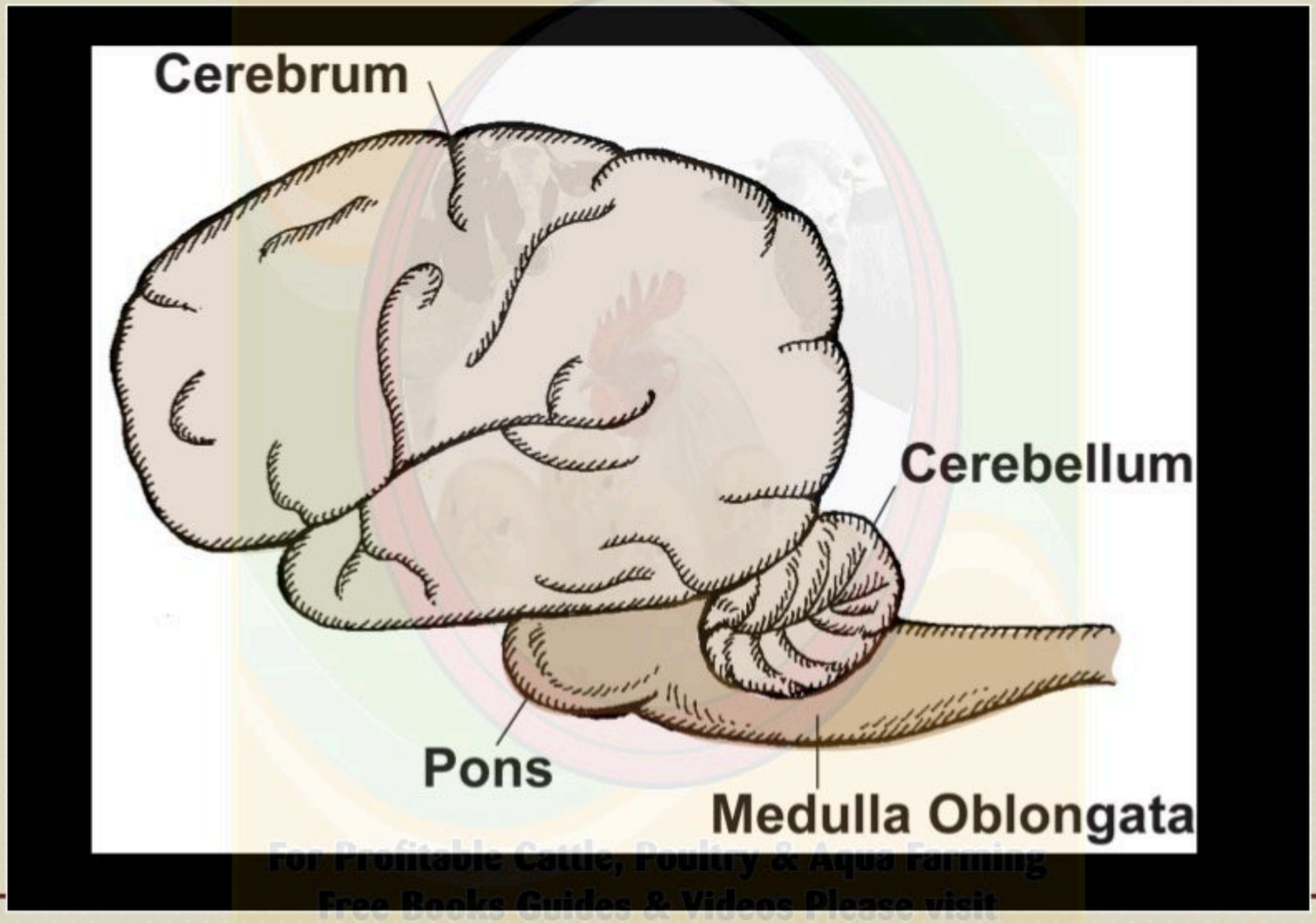
- Nerves that carry messages from the brain to muscles or glands are called motor or efferent neurons.

Brain

The brain is made up of four major parts:

- Cerebrum
- Cerebellum
- Pons
- Medulla oblongata

Brain



Cerebrum

- The cerebrum is the largest part of the brain.

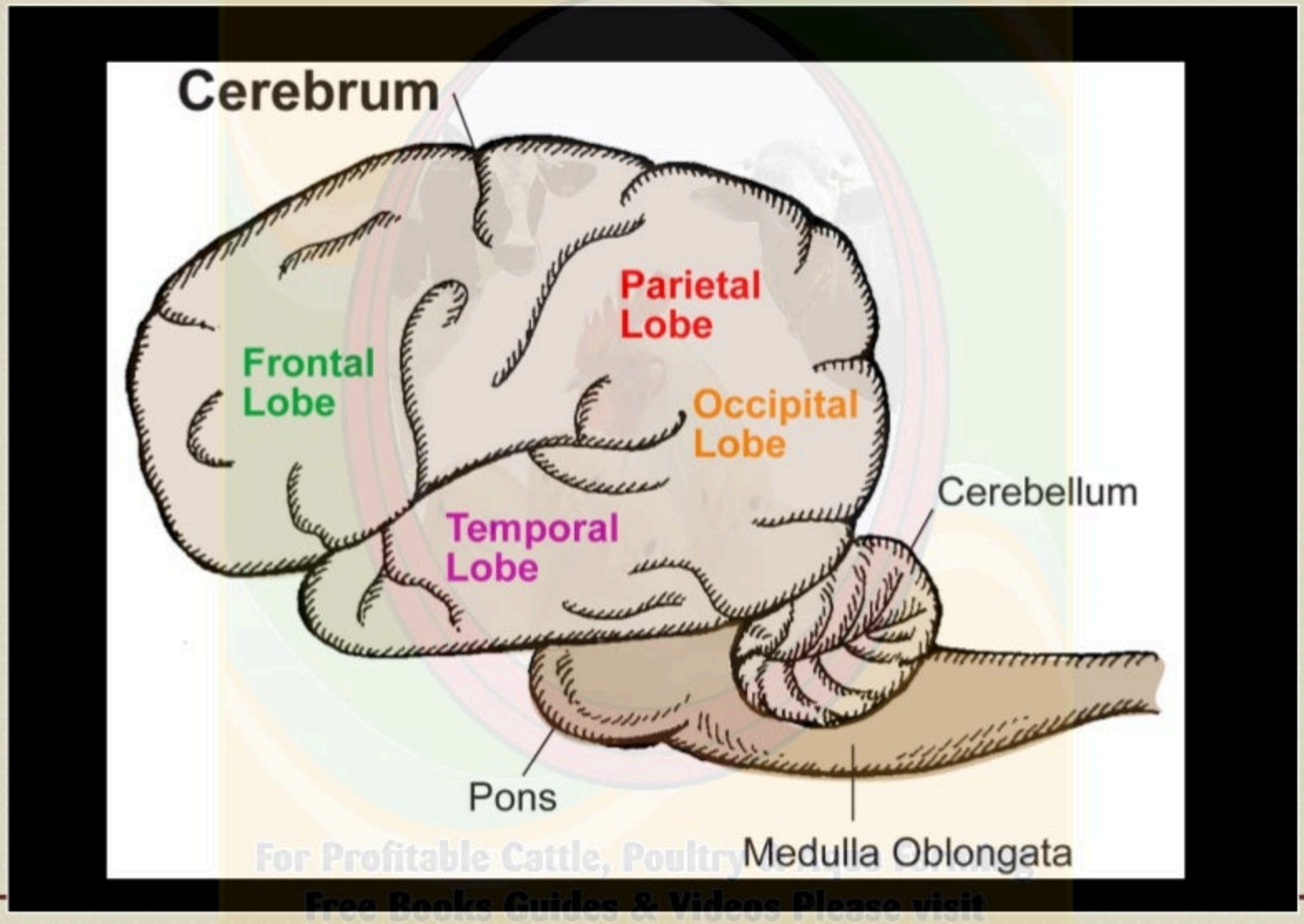
- The cerebrum is responsible for the decision-making or thinking processes that control voluntary muscle activity and for reactions to stimuli that are processed by the senses.

Cerebrum

The cerebrum is divided into the left and right side or hemisphere. Each hemisphere is divided into four lobes:

- Frontal
- Parietal
- Temporal
- Occipital

Brain



Brain

- The right hemisphere processes creative and emotional stimuli.
- The left hemisphere processes actions and is involved in learning.
- The right side controls the left side of the body and the left side controls the right.

Cerebellum

- The Cerebellum serves as a coordinator of messages from other parts of the brain to the body.

- The Cerebellum also coordinates the action of voluntary muscles in activities such as walking, running, eating, and talking.

Brain (Reflex Actions)

- Involuntary (reflex actions), such as blinking, vomiting, breathing, and swallowing are controlled by the pons and medulla oblongata, which act independently of the other two parts of the brain.

Spinal Cord

- The spinal cord is located at the center of the vertebral column.

- The spinal cord is the main avenue for message transferal between the brain and the other parts of the body.

Spinal Cord

- The spinal cord is divided into segments; A pair of spinal nerves extends to the body from each part.
- The spinal cord receives messages from sensory nerve fibers in various parts of the body and transmits them to the brain.
- Motor nerve fibers in the spinal cord then transmit the response from the brain back to the body.

Peripheral Nervous System

- The peripheral nervous system is responsible for transmitting messages between the outer part of the body and the brain.

- The peripheral nervous system is made up of somatic and autonomic nerves.

Peripheral Nervous System

- Somatic nerves include all the nerve structures located outside the brain and spinal cord.

- They convey sensations from sensory organs such as the eyes and nose.

Peripheral Nervous System

- Autonomic nerves are also located outside of the central nervous system.

- Autonomic nerves control the functions of muscles in internal organs, such as the heart and stomach.

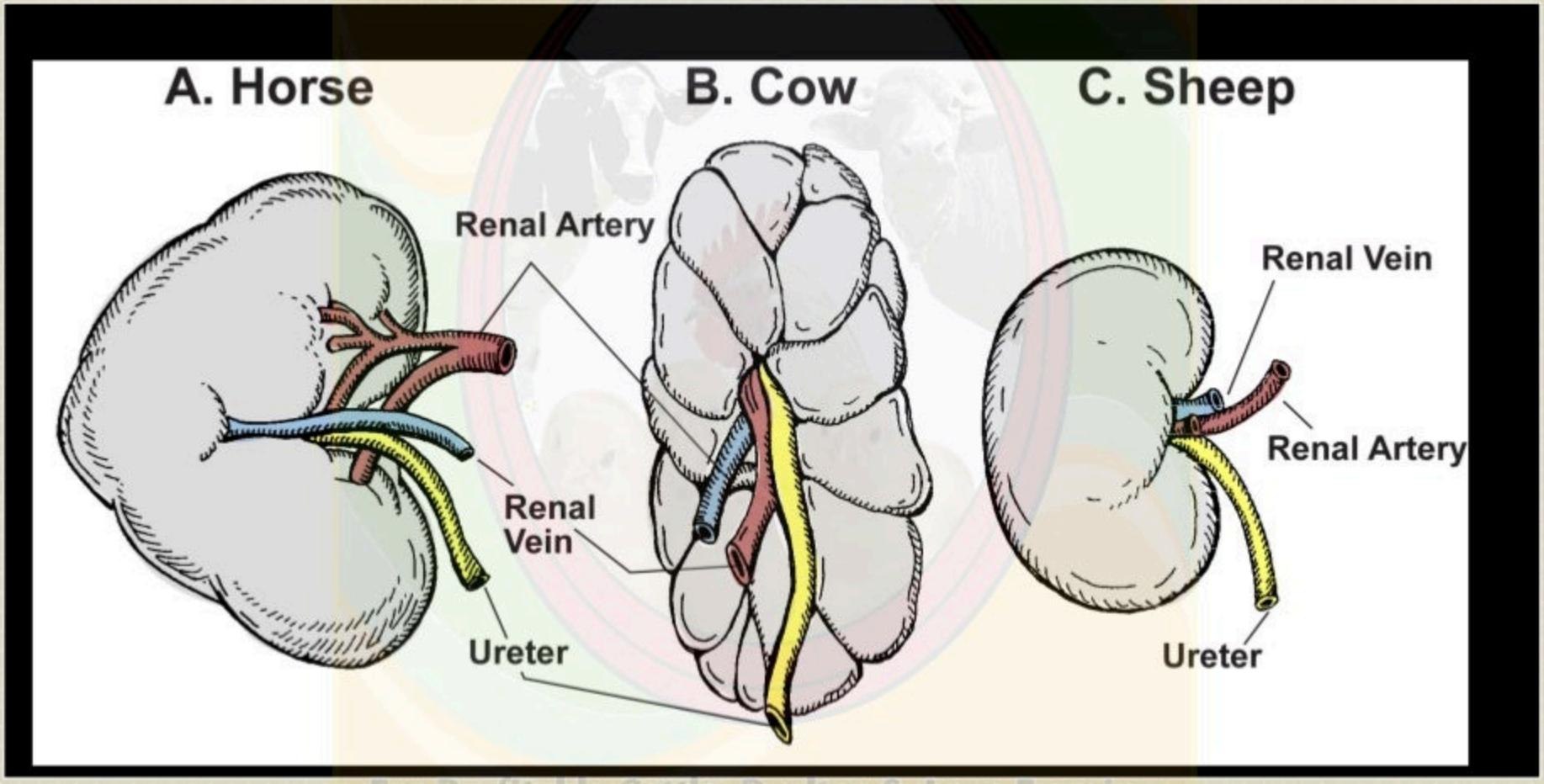
Urinary System

Urinary System

The urinary system:

- Removes wastes
- Helps maintain the correct balance of water and minerals in the body

Urinary System



Urinary System

The urinary system includes the:

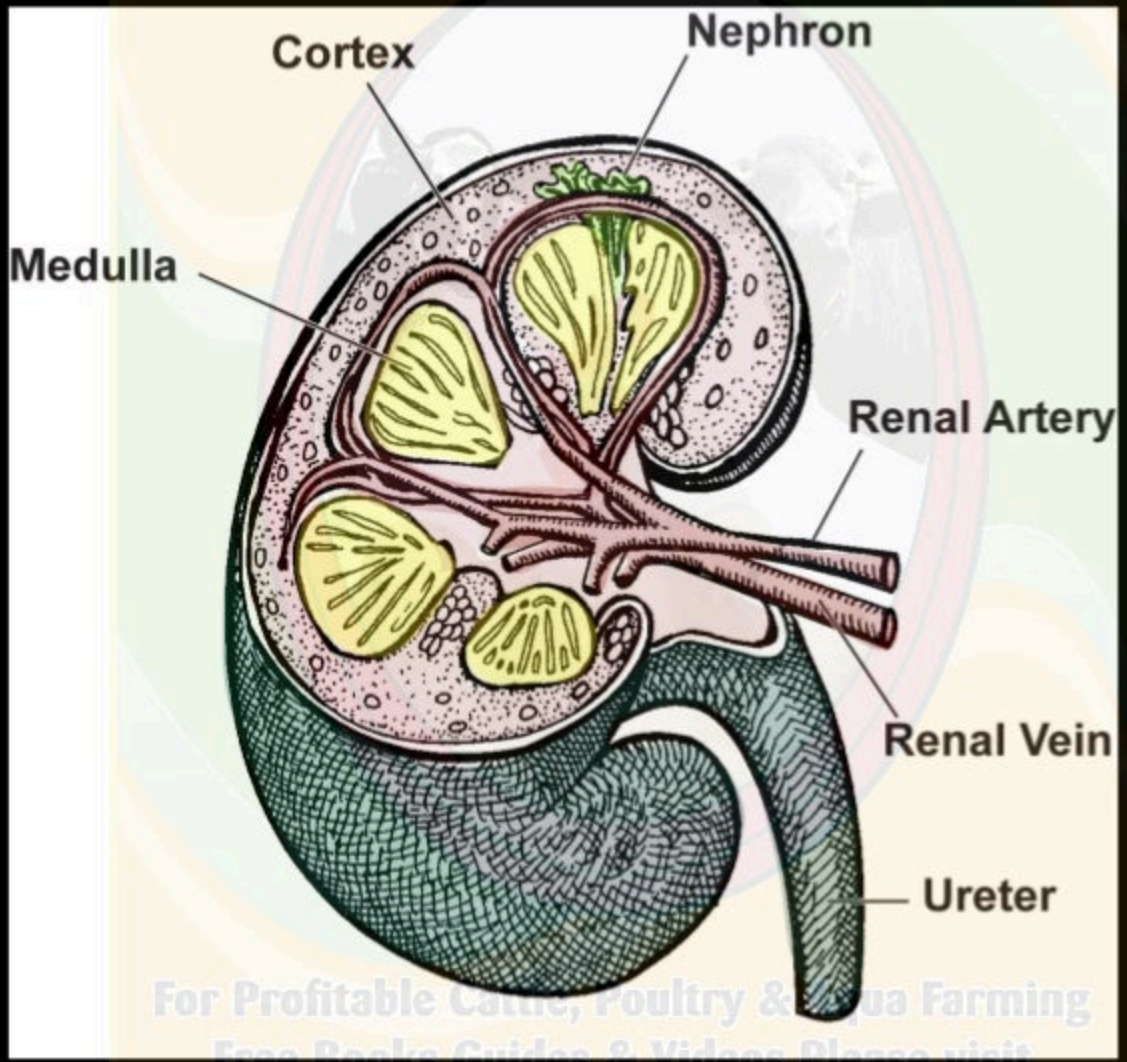
- Kidneys
- Ureters
- Bladder
- Urethra

Urinary System (Kidney)

Each kidney is composed of:

- An outer tissue layer, call the renal cortex
- An inner portion called the renal medulla

Urinary System



Kidneys

- Filter waste products from the blood including mineral salts, urea, uric acid, and creatinine.

- Regulate blood composition and maintain normal internal life support conditions.

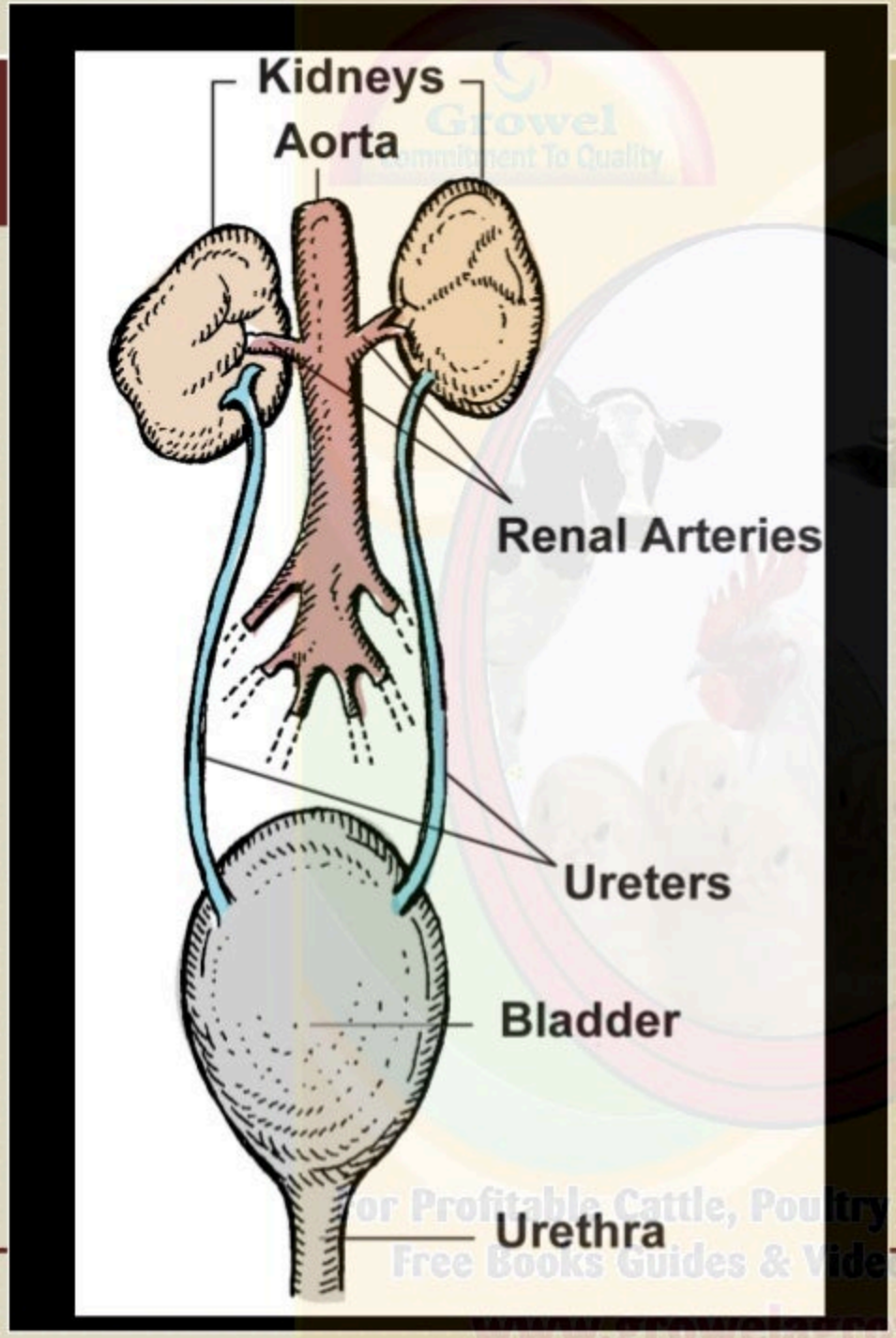
Ureters

Ureters are the tubules connecting the kidneys with the bladder. They are responsible for:

- Transporting urine from the kidneys to the bladder.

Urinary System

(anterior or ventral view)

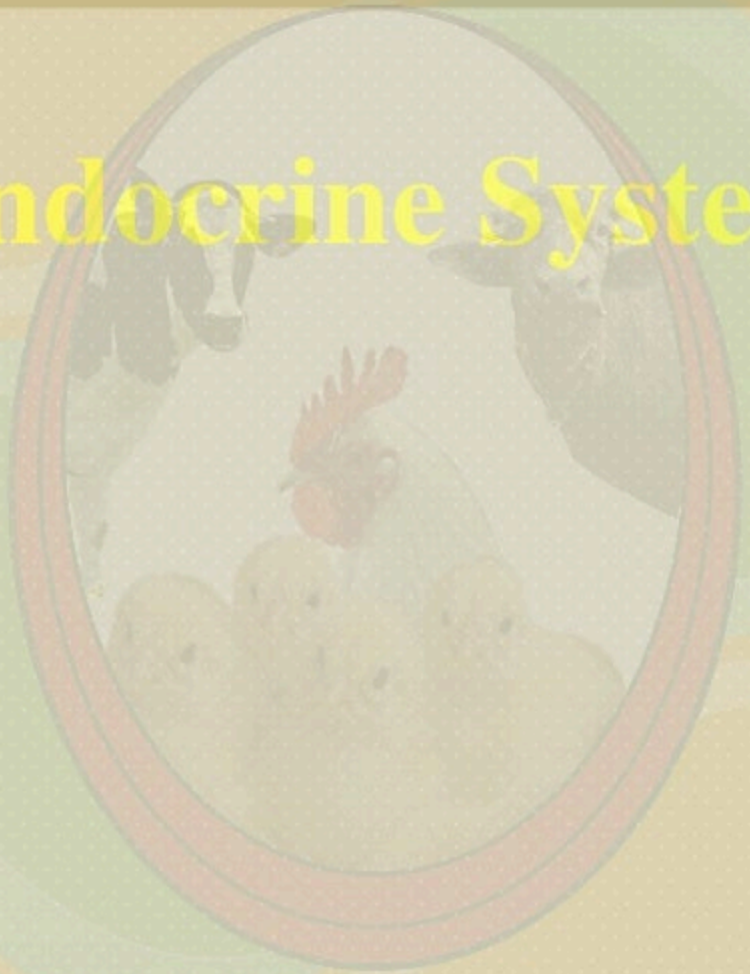


Bladder / Urethra

- The bladder is an expandable sac that stores the urine until it is excreted from the animal's body.

- Urine passes through an elastic tube called the urethra to be removed from the body.

Endocrine System



Endocrine System

- A network of glands that secrete hormones, which provide chemical control of various functions of the body.

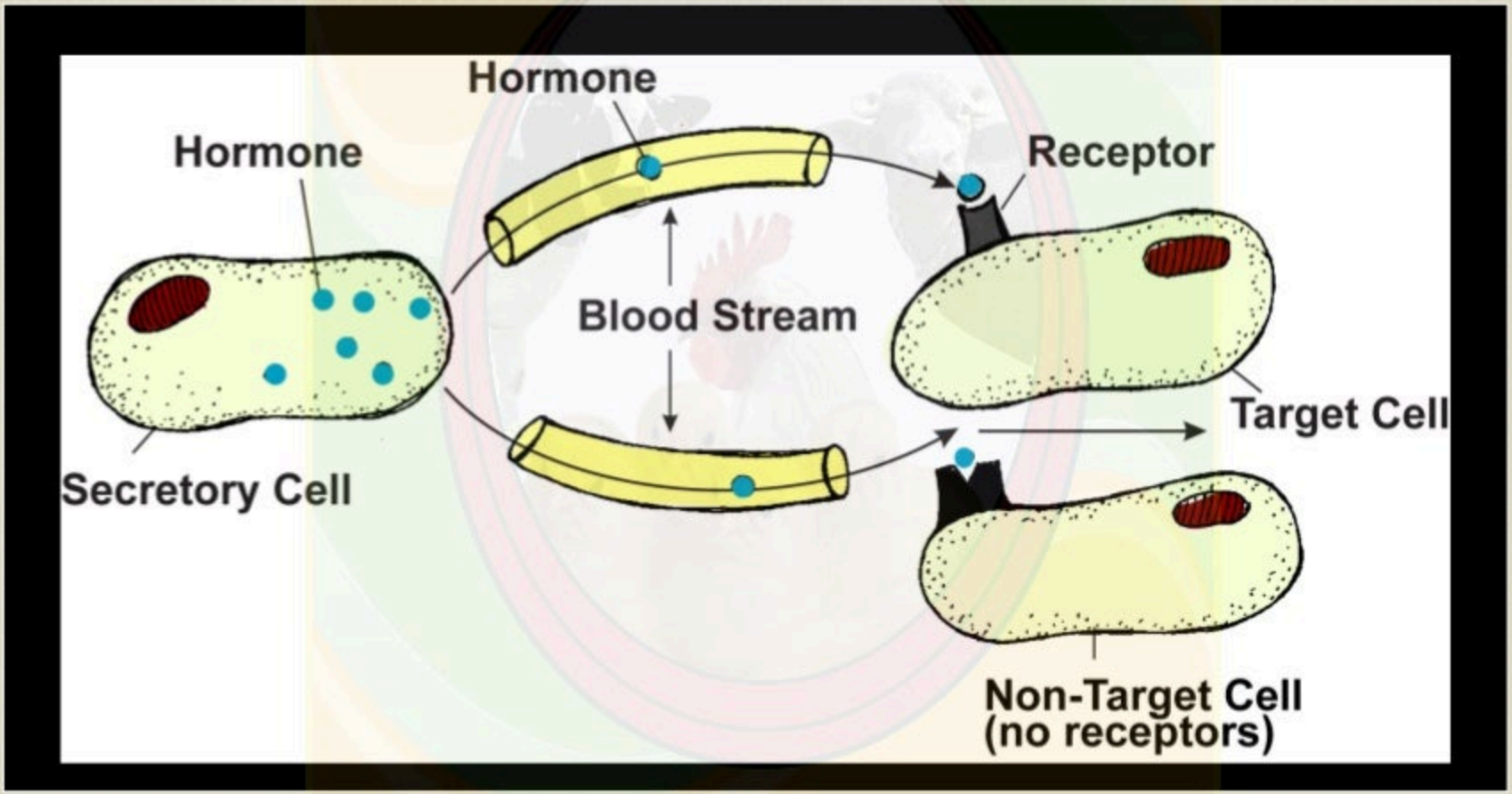
- Endocrine glands secrete chemical compounds called hormones into the blood system.

Endocrine System

- Hormones are secreted from a secretory cell in a gland and act on a target cell at another part of the body.

- Target cells must have receptors for the specific hormone.

Endocrine System



Hormones

Hormones play an important role in body functions including:

- Growth
- Fattening
- Reproduction
- Lactation
- Egg Laying

Hormones

There are three types of hormones that can be grouped by their chemical structure:

- Steroids
- Peptides
- Amines

Steroids

- Lipids that are secreted by the gonads, adrenal cortex and placenta.

- Two common steroid hormones are progesterone and testosterone.

Peptides

- Short chains of amino acids secreted by the pituitary gland, parathyroid gland, heart, stomach, kidneys, and liver.

- Peptide hormones include oxytocin, luteinizing hormone, thyrotropin releasing hormone.

Amines

- Secreted from the adrenal medulla and the thyroid.

- Amine hormones include epinephrine, norepinephrine, T3 (triiodothyroxin), and T4 (tetraiodothyroxin).

Hypothalamus Gland

- The hypothalamus gland is located directly above the pituitary gland near the base of the brain.

- The hypothalamus gland coordinates hormonal activity in the pituitary gland.

Pituitary Gland

- Stimulatory and inhibitory hormones are produced by the hypothalamus and transported to the anterior pituitary.

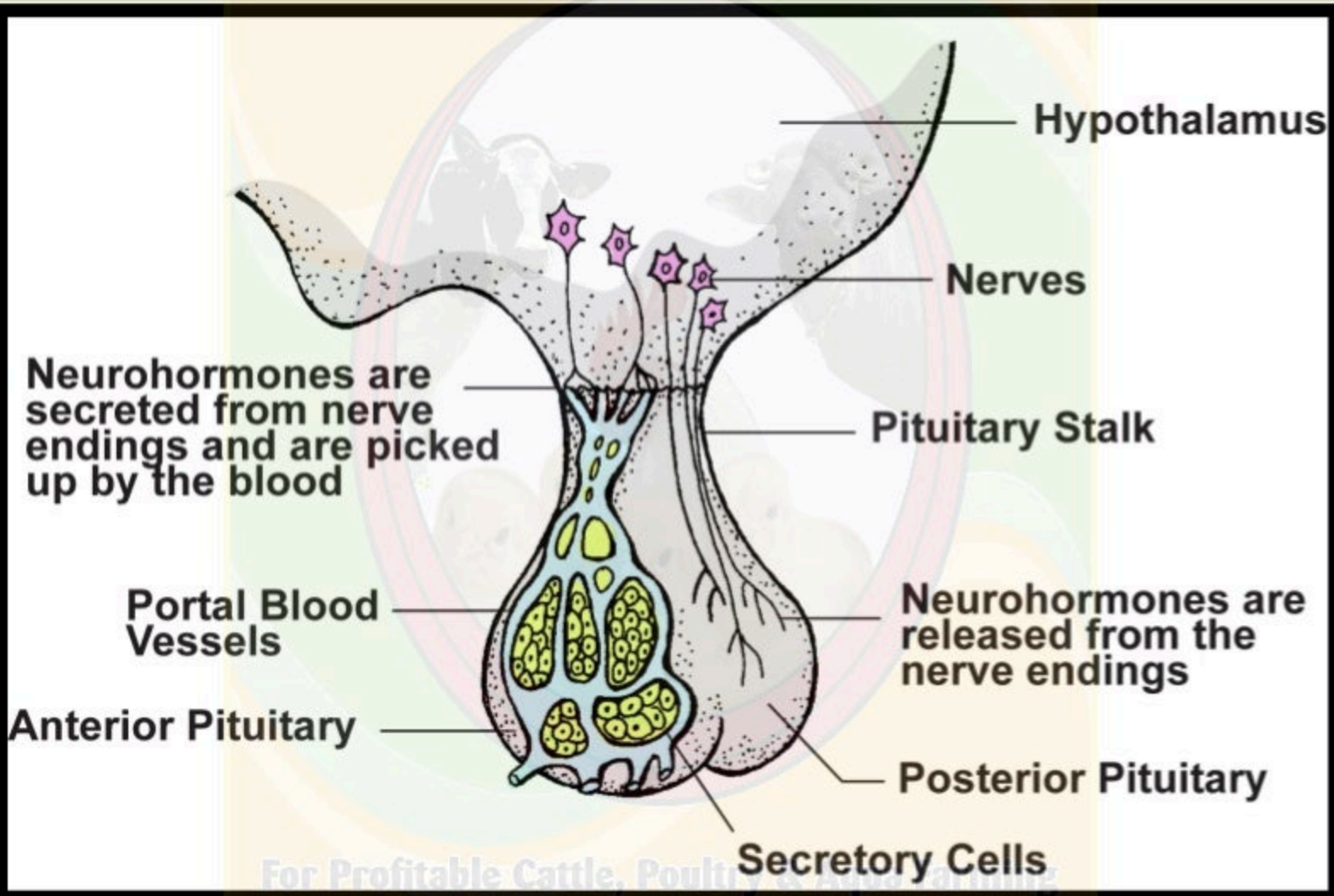
- Hormones are transported to the anterior pituitary through the blood.

- The hormones oxytocin and vasopressin, travel to the pituitary by means of nerve cells.

Pituitary Gland

- The pituitary gland is located at the base of the brain.
- It is composed of two parts, the anterior and posterior pituitary glands.
- The pituitary controls the hormonal secretions of numerous endocrine glands.

Endocrine System



Thyroid Gland

Thyroid Gland consists of two connected lobes located on either side of the trachea or windpipe.

- Thyroxine, produced by the thyroid gland controls body metabolism and growth.

- Calcitonin, also produced by the thyroid controls the calcium level in the blood and promotes the incorporation of calcium into the bone.

Parathyroid Glands

- The parathyroid glands include four small gland embedded in the thyroid.

- The parathyroid glands produce parathyroid hormone, which maintains the level of calcium and phosphorus in the blood.

Adrenal Glands

- The adrenal glands, consisting of the a medulla and a cortex, are located in front of the center of the kidneys.

- The medulla produces norephinephrine, which helps maintain blood pressure and stimulates smooth muscles.

Adrenal Glands

- The cortex produces steroids, which are involved in carbohydrate and fat metabolism.

- The production of hormones by endocrine glands is carefully balanced, and an imbalance can result in illness or improper development of the animal.

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