ANIMAL SCIENCE MANUAL

ANIMAL SCIENCE REVIEW DASHBOARD								
	Topics	**#**	**Subtopic**	**Days left**	**Schedule**	**URC Lecture**	**Review Manual**	**Status**
	PRETEST SCORE							
1	**Introduction**	1	Economic Utility Derived from Animals					
		2	Farm Animals and Scientific Names					
		3	Commonly Used terms					
			QUIZ					
2	**Anatomy and Physiology of Farm Animals**	4	Commonly Used terms					
		5	Nervous System					
		6	Endocrine System					
		7	Cardiovascular System					
		8	Lymphatic System					
		9	Respiratory System					
		10	Digestive System					
		11	Excretory System					
		12	Reproductive System					
		13	Body Temperature Regulation					
			QUIZ					
3	**Animal Nutrition**	14	Classes of Nutrients and their Characteristics					
		15	Growth and Maintenance					
		16	Feeds and Nutrient Sources					
		17	Feed Formulation					
			QUIZ					
4	**Genetics and Livestock Improvement**	18	Important Contributors to the Field of Genetics					
		19	Commonly Used terms					
		20	GxE Interaction					
		21	Gene Action					
		22	Mechanics of Inheritance					
		23	Mendelian Inheritance					
		24	Non-Mendelian Inheritance					
		25	Genes in Population					
		26	Animal Breeding					
		27	Systems of Breeding					
		28	Animal Reproduction and rate of Genetic Improvement					
			QUIZ					
5	**Slaughter, Processing and Marketing Farm Animals**	29	Commonly Used terms					
		30	Selecting Animals for Slaughter					
		31	Steps in Slaughtering					
		32	Meat and Meat Products					
		33	Milk Production					
		34	Egg Production					
			QUIZ					
6	**Poultry Production**	35	Chicken, classes, breeds and Varieties					
		36	Specialized fields in Poultry Production					
		37	Poultry Reproductive System					
		38	Brooding Management					

		39	Growing Management					
		40	Layer Flock Management					
		41	System of Broiler Production					
			QUIZ					
7	**Swine Production and Management**	42	Breeds of Swine					
		43	Production System					
		44	Management of Boars					
		45	Care and Management of Sows and Gilts					
			QUIZ					
8	**Goat and Sheep Production**	46	Sheep Breeds					
		47	Goat Breeds					
		48	Breeding and Management Practices					
		49	Feed Resources and Feeding Management					
		50	Health Management					
			QUIZ					
9	**Beef Cattle Production and Management**	51	Beef Production Systems in the Philippines					
		52	Beef Cattle Nutrition					
		53	Herd Management					
		54	Housing Facilities					
			QUIZ					
10	**Dairy Production**	55	Milk and Milk Products					
		56	Breeds of Dairy Cattle					
		57	Dairy Cattle Reproduction					
			QUIZ					
11	**Carabao Production and Management**	58	Types and Breeds of Water Buffalo					
		59	Breeding					
		60	Care and Management of Buffaloes					
		61	Management of Bulls					
		62	Feeding Systems					
		63	Animal Health Management					
			QUIZ					
12	**Poultry Production Computations**		***Layer:***					
		64	Feed Conversion					
		65	Feed Cost per Dozen of Eggs Produced					
		66	Hen-day Egg Production					
		67	Hen-housed Egg Production					
		68	Feed Efficiency per Kg Egg Mass					
		69	Feed Efficiency per Dozen Eggs					
			Broiler:					
		70	Feed Conversion					
		71	Feed Cost/Kg of Broiler Produced					
		72	Production Efficiency Factor					
		73	Harvest Recovery					
		74	Dressing Percentage					

			QUIZ					
13	**Swine Production Computations**	75	Litter Index					
		76	Number of Piglets Weaned per Sow per Year					
		77	Number of Piglets Born per Litter					
		78	Number of Stillborn per litter					
		79	Number of Piglets Born Alive per Litter					
		80	Pre-weaning Mortality %					
		81	Average Daily Gain					
		82	Feed Conversion Ratio					
			QUIZ					
14	**Breeding and Genetics Computations**							
			QUIZ					
	POST-TEST SCORE							

Basic Concepts

ANIMAL SCIENCE

- Science and business of producing domestic animal species, including but not limited to beef cattle, dairy cattle, horses, poultry, sheep and swine; also concerned with foods of animal origin: meat, dairy foods and eggs (ASAS).

ANIMAL SCIENTIST

- applies principles of the biological, physical and social sciences to the problems associated with livestock production and management (ASAS).

Scientific Names

- **Chicken** – *Gallus gallus*
- **Mallard duck** – *Anas platyrhnchos*
- **Muscovy duck** – *Cairina moschata*
- **Goose** – *Anser domesticus*
- **Turkey** – *Meleagris gallopavo*
- **Pigeon** – *Columba livia*
- **Quail** – *Coturnix coturnix*
- **Guinea fowl** – *Numida meleagris*
- **Pig** – *Sus scrofa*
- **Cattle (no hump)** – *Bos taurus*
- ***Cattle* (with hump) –** *Bos indicus*
- **Buffalo** – *Bubalus bubalis*
- **Sheep** – *Ovis aries*
- **Goat** – *Capra hircus*

Animal Science Terms

I. Cattle and carabao

- **Bull** – male breeding ox of any age
- **Bull calf** – young male under one year of age
- **Bullock** – a stag for draft purposes
- **Calf** – young ox of either sex, under one year of age
- **Cattle** – domesticated bovine animals
- **Cow** – mature female ox, one that has already given birth
- **Carabull** – mature male carabao
- **Caracow** – mature female carabao, one that has already given birth
- **Caraheifer** – young female carabao under three years of age, one that has not yet given birth
- **Heifer** – young female ox under three years of age, one that has not yet given birth
- **Proven sire** – a bull that has sufficient information indicating its transmitting ability
- **Ox** – member of the bovine family, or sometimes the male used for draft purposes
- **Stag** – male ox castrated after sexual maturity
- **Steer** – male ox castrated before sexual maturity.

II. Horse

- **Broodmare** – a female horse used for breeding.
- **Colt** – young male horse, usually up to three years of age
- **Equtation** – horsemanship, the art of horseback riding
- **Filly** – young male horse, usually up to three years of age
- **Foal** – young horse of either sex

below one year of age
- **Gelding** – male horse castrated while young
- **Mare** – mature female horse
- **Ridgling** – stallion with only one testis or none in its scrotum
- **Stallion** – mature male horse
- **Stud horse** – a stallion used for breeding
- **Yeld mare or dry mare** – a mature female horse that has not produced any offspring during the breeding season

III. Swine

- **Boar** – mature intact male pig
- **Barrow** – male pig castrated while young, before the development of its secondary sex characteristics
- **Gilt** – young female pig up to one year of age, usually one that has not yet given birth
- **Litter** – a group of pigs born in one farrowing
- **Litter size** – the number of piglets born in one farrowing
- **Shote** – young pigs of either sex weighing approximately 60 kg
- **Sow** – mature female pig, one that has given birth
- **Stag** – male pig castrated after sexual maturity
- **Suckling** – young pigs from birth up to weaning
- **Weanling** – young pigs weaned from the sow, about five weeks old

IV. Sheep and goat

- **Billy goat or buck** – male goat of any age
- **Doe** – female goat of any age
- **Ewe** – female sheep of any age
- **Fleece** – wool covering the sheep
- **Kid** – young goat of either sex below one year old
- **Lamb** – young sheep of either sex below one year of age
- **Pelt** – wool and skin of sheep
- **Ram** – male sheep of any age for breeding purposes
- **Shearling** – yearling sheep with two teeth
- **Wether goat** – male goat castrated before the development of its secondary sex characteristics
- **Wether sheep** – male sheep castrated while young, preferably between 1 and 3 weeks of age

V. Poultry (chicken, duck, muscovy, turkey, quail, goose)

- **Capon** – a caponized male, readily distinguished by undeveloped comb and wattles
- **Chick** – young chicken while in the down stage
- **Chicken** – one of the more common poultry species different from turkey, goose, etc.
- **Cockerel** – a male fowl less than one year old
- **Drake** – a male duck
- **Duck** – a female duck
- **Duckling** – young duck in the down stage

- **Poult** – the young of the domestic turkey, properly applied until sex can be distinguished
- **Poultry** – collective term for all domestic birds rendering economic service to man; also refer to dressed fowl carcass
- **Plumage** – the feathers of a fowl
- **Pullet** – a female fowl less than one year old
- **Rooster** – a male fowl one year old or over

Definition of Terms

- **Parturition** – the act of giving birth
  - Calving – in cows
  - Farrowing – in sows
  - Foaling – mares
  - Kidding – in goats
  - Lambing – in ewes

- **Conception** – act of fertilization

- **Dam** – female parent

- **Fecundity/Prolificacy** – ability to give birth to offspring frequently or to numerous young at frequent intervals

- **Fertility** – ability to produce fertilizable ova and to provide proper environment for and initiating cell division and embryonic development; ability to produce large number of sperms capable of fertilization

- **Gestation** – pregnancy time from conception to birth

- **Impotency** – failure to copulate

- **Puberty** – sexual maturity, as exhibited by first heat or ovulation

- **Sire** – the male parent

- **Sterility** – inability to produce normal young

- **Transmitting ability** – the ability of an animal to pass on either good or bad traits to its progeny

- **Weaning** – the process of separating the young from its dam

- **Weanling** – young animal after separation from its dam

- **Anatomy** – the study of form and structure of animals

Anatomy & Physiology

External Anatomy

- Structures found outside the body with integral part or parts of the organ systems located internally
- Generally involved in the following functions:
  1. Protection/covering such as feathers, hairs, horns, skin, etc.
  2. Digestion like mouth, beak, bill, snout, muzzle, etc.
  3. Sensation such as skin, nostrils, eyes, ears
  4. Aesthetic like comb, wattles, feathers

Internal Anatomy

- Organs and organ systems that function in a well-coordinated manner to enable survival, growth and reproduction
- Generally located in the following:
  1. Thoracic cavity – lungs, heart
  2. Abdominal cavity – stomach, small intestine, pancreas, liver, spleen, large intestine, kidneys, adrenals
  3. Pelvic cavity – reproductive organs

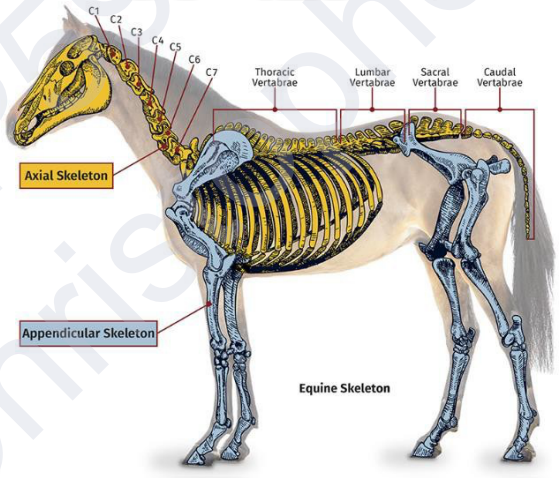
Physiology – the study of the functions of the parts or organ systems of the body; a study of function of living matter; provides the means by which environmental stimuli are perceived and a body reaction occurs

Homeostasis – the maintenance of static or constant conditions in the internal environment

I. SKELETAL SYSTEM

Division of Skeletal System

1. Axial Skeleton
- all bones except limbs or appendages
- skull, vertebrae and ribs



2. Appendicular Skeleton
- Bones of the limbs
- Pectoral limbs and pelvic limbs

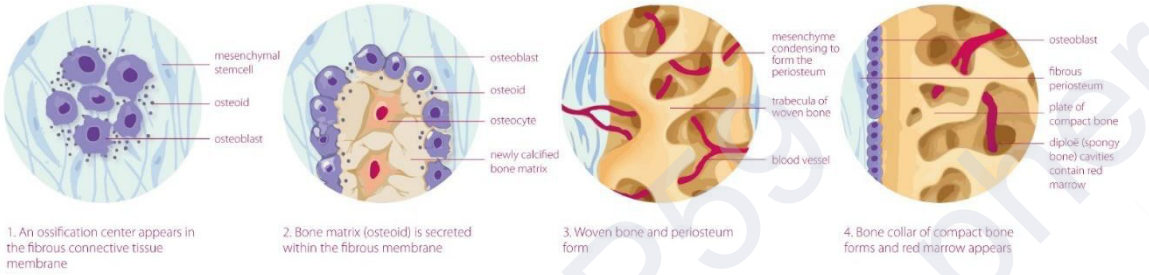
Bones – highly specialized supportive tissue characterized by its rigidity and hardness

- Main functions
  - ▶ Mechanical support (ribs)
  - ▶ Locomotion (long bones)
  - ▶ Protection (skull)
  - ▶ Metabolic reservoir of minerals

- **Composition:**

A. **Cell** – bones are composed of 4 cell types

1. **Osteogenic cells** – Mesenchymal cells
2. **Osteoblast cells** – bone secreting cells
3. **Osteocyte cells** – mature bone cells that stop secreting bone substance
4. **Osteoclasts** – remodeling cells



B. **Osteoid** – unmineralized organic portion of the bone matrix made up of collagen and glycosaminoglycan

C. **Inorganic mineral salts deposits**

Types of Bone

1. **Cancellous or trabecular or spongy bone –** consist of many interosseous space

2. **Compact or cortical bone or lamellar bone** – consist of extensive lamellae

- **Osteon or Haversian System** – basic unit of a compact bone

- **Osteogenesis** – process of bone formation through the secretory activity of osteoblasts

- **Epiphyseal Plate or Epiphyseal Line** – site of bone growth (long bones), composed of 3 zones: growth zone, cartilage transformation zone, ossification zone.

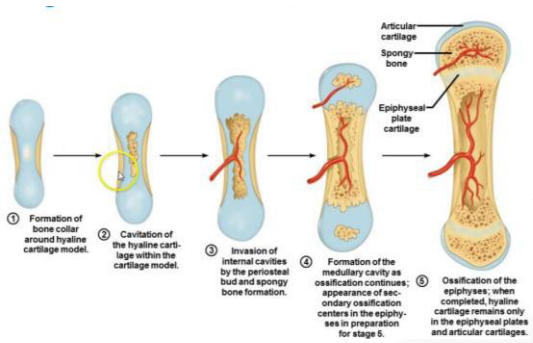
Bone Formation Process

A. Intramembranous ossification

1. Mesenchymal cells group into clusters, and ossification centers form.
2. Secreted osteoid traps osteoblasts, which then become osteocytes
3. Trabecular matrix and periosteum form.
4. Compact bone develops superficial to the trabecular bone, and crowded blood vessels condense into red marrow.

Endochondral Ossification

1. The cartilage model of the future bony skeleton and the perichondrium form
2. capillaries penetrate the cartilage. Perichondrium transforms into periosteum. Primary ossification center develops
3. Cartilage and chondrocytes continue to grow at ends of the bone
4. Secondary ossification centers develop
5. Cartilage remains at epiphyseal (growth) plate and at joint surface as articular cartilage



Bone Classification

1. **Long bones**
   - Function: act as levers; for support and locomotion
   - Example:
     - ▶ Forelimb – humerus, radius, ulna, metacarpals, phalanges
     - ▶ Hind limb – femur, tibia, fibula, metatarsals, phalanges

2. **Short bones**
   - Function: absorbs concussion
   - Example: carpals and tarsals

3. **Flat bones**
   - Function: protects vital organs (brain, lungs)
   - Provide areas for muscle attachment
   - Skull, ribs, scapula, pelvic bones

4. **Sesamiod bones**
   - Function: reduce friction; change the course of tendons
   - Example: patella

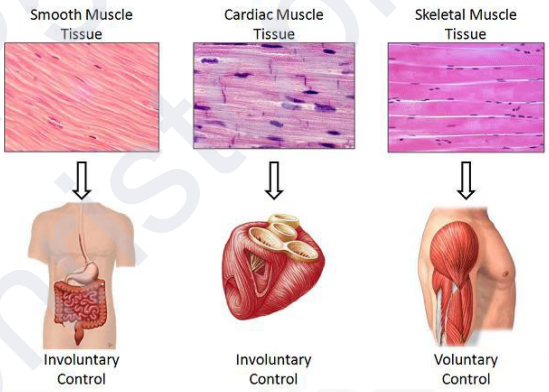
5. **Irregular bones**
   - Function: protection and support; muscle attachment
   - Example: Vertebral column, some bones of skull

6. **Pneumatic bones**
   - Function: with air spaces or sinuses that communicate with the exterior
   - Example: flying birds, maxillary and frontal bones

II. MUSCULAR SYSTEM

- Functions: creates movements; protects vital organs; cardiac muscles pump blood; and smooth muscles aid digestion and ensure blood flow

Types of Muscle Tissue



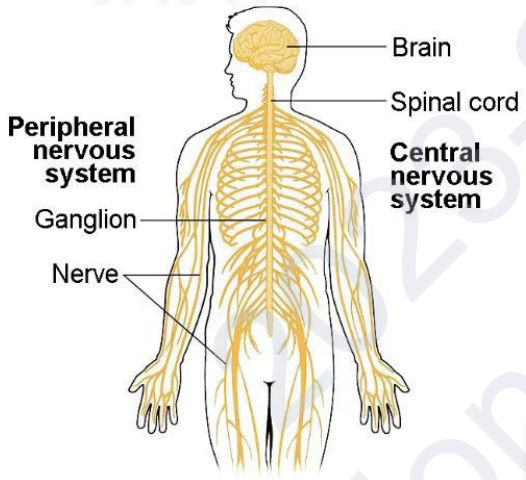
1. **Skeletal Muscles**
   - Function: attach to and move bones by contracting and relaxing in response to voluntary messages from the nervous system

2. **Smooth Muscles**
   - Functions:
     - found in the walls of hollow organs
     - contractions are involuntary
     - movements triggered by impulses that travel through the autonomic nervous system to the smooth muscle tissue
     - smooth muscle in **walls of organs** like the urinary bladder and the

uterus allows these organs to expand and relax
- smooth muscle of **alimentary canal** (the digestive tract) facilitates the peristaltic waves that move swallowed food and nutrients
- **eye smooth muscle** changes the shape of the lens to bring objects into focus
- **artery walls** include smooth muscle that relaxes and contracts to move blood through the body

3. Cardiac Muscles

- Three layers of the heart: pericardium, myocardium and endocardium



Myocardium: middle layer is responsible for the heart's pumping action
- the cardiac muscle is found only in the myocardium, and contracts in response to signals from the cardiac conduction system to make the heart beat

III. NERVOUS SYSTEM

Basic unit of the nervous system

- **The nerve cells or neurons -** specialize in impulse conduction or the relay of messages from effector organs to the nervous system and vice versa

- **Synapse** – a gap between two neurons, where nerve impulses are transmitted from one nerve cell to another. Classified according to the direction of impulse conduction:

1. **Afferent (sensory) neurons** – transmit nerve impulses from the effector organ to the spinal cord or brain

2. **Efferent (motor) neurons** – transmit nerve impulses away from the brain or spinal cord or towards muscles or glands

3. **Interneurons** – conduct impulses from an afferent neuron within the central nervous system

Divisions of the Nervous System

1. **The Central Nervous System (CNS)**
   - the main processing unit of the body
   - includes the brain (enclosed by the skull) and the spinal cord (enclosed by the vertebral column)

2. **The Peripheral Nervous System (PNS)**
   - composed of nerves emerging from the CNS

Divisions of the Peripheral Nervous System

1. **Somatic**
   - supplies and receives nerve fibers (neurons) to and from the skin, skeletal muscles, joints and tendons
   - brings about quick adjustments of the muscles to changes in the environment

2. **Autonomic/Visceral**
   - supplies and receives nerve fibers to and from smooth muscles, cardiac muscle and glands
     - ▶ made up to visceral motor fibers (those supplying smooth muscles, cardiac muscles and glands)

2 Subdivisions of the Autonomic Nervous System:

1. **Parasympathetic (Cranio-Sacral) division** – important for the control of 'normal' body functions e.g. normal operation of digestive system; "rest & digest"

2. **Sympathetic (Thoracolumbar) division** – important in helping cope with stress; "fight or flight"

IV. ENDOCRINE SYSTEM

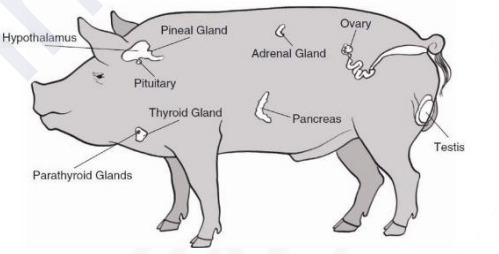
- **Endocrinology** – a branch of physiology that deals with the coordination of various body tissues by chemical mediators produced by restricted areas of the body and transported through the circulatory system to the organ or tissue on which they exert their effects
- **Hormone** - chemical mediator produced by the endocrine glands and secreted into the bloodstream to some distant part of the body with the target cells where it exerts its effect

Classification of Hormones According to Chemical Composition

1. **Polypeptides** – chains of amino acid, each less than 100 amino acids long

2. **Glycoproteins** – polypeptide chain, longer than 100 amino acids, attached to a carbohydrate
   Ex. Follicle-stimulating Hormone (FSH) and Luteinizing Hormone (LH)

Endocrine glands of animals



3. **Amines** – hormones derived from the amino acids tyrosine and tryptophan.
   - Ex. Catecholamines (adrenaline and noradrenaline), which are often secreted in response to stress

4. **Steroids** – lipids derived from cholesterol
   Ex. Corticosteroids secreted from the adrenal gland balance solutes such as glucose and salt in the body

Hypothalamus – part of the brain that has a vital role in controlling many bodily

functions including the release of hormones from the pituitary gland

Functions:

1. control of the autonomic nervous system
2. reception of sensory impulses from the viscera
3. intermediary between the nervous and endocrine systems
4. control of body temperature
5. regulation of food intake
6. thirst center
7. part of the limbic system – emotions, aggression
8. part of reticular formation

Pituitary Gland or Hypophysis

- location: base of the brain in a concavity of the sphenoid bone called *Sella turcica* which protects it from outside pressure
- composed of 3 lobes:

1. **Anterior** (adenohypophysis) which secretes the following hormones:
   a) Somatotrophic Hormone (STH) – promotes growth of long bones
   b) Adrenocorticotrophic Hormone (ACTH) – stimulates the adrenal cortex
   c) Thyroid Stimulating Hormone (STH) - stimulates the thyroid gland
   d) Luteotrophic Hormone (LTH) - stimulates milk secretion
   e) Follicle Stimulating Hormone (FSH) - stimulates development of ovarian follicles and influences the formation of spermatocytes
   f) Luteinizing Hormone (LH) – stimulates ovulation in females and testosterone secretion in males
2. **Intermediate** (pars intermedia)
3. **Posterior** (neurohypophysis) which secretes the following hormones:
   a. Antidiuretic hormone – promotes water reabsorption in the kidneys to prevent excessive dehydration
   b. Oxytocin – stimulates uterine contraction and milk-ejection

Thyroid Gland

Location: below the larynx, composed of two lateral lobes connected by isthmus

Functions:

- maintains the level of metabolism in the tissues
- secretes T4, thyroxine, which increases the basal metabolic rate
- secretes T3, triodothyronine, which, along with T4, stimulates the oxygen consumption of most of the cells in the body and helps regulate lipid and carbohydrate metabolism
  - **Excess thyroid secretion** – body wasting, nervousness, excess heat production, thyrotoxicosis
  - **Hypothyroidism** – simple goiter; lack of thyroxine secretion due to iodine deficiency
- Also secretes Calcitonin / Thyrocalcitonin in response to stimulation from the parathyroid gland

Parathyroid Gland

Location: dorsal to the thyroid gland
Functions:

- produces Parathyroid Hormone (PTH) – increases the level of calcium in the blood by the mobilization of calcium from the bones, and enhances Ca and P absorption from the intestinal tract
- stimulates Calcitonin (lowers calcium level) secretion in the thyroid gland in response to increasing calcium level in the blood

Pancreas

Location: Abdomen; adjacent to the small intestine
Functions:
- produces **insulin** (decreases blood glucose concentration) in its beta-cells and **glucagon** (increases blood glucose concentration) in its alpha-cells

Adrenal Gland

Location: cranial to the kidneys
Functions:
- consists of the **adrenal cortex** which secretes glucocorticoids, androgens and mineralocorticoids; and the **adrenal medulla** which secretes epinephrine and norepinephrine

Pineal Gland

Location: near the center of the brain
Function:
- secretes melatonin which is responsible for photoperiod-related behavior of animals (ex. Circadian rhythm, seasonal breeding & egg production)

V. CARDIO-VASCULAR SYSTEM

Functions:

- -conveys nutrients absorbed from the digestive tract to the tissues
- carries oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs
- removes waste products of metabolism and takes them to the excretory organs for disposal
- transports hormones from one part of the body to another
- helps in maintaining water equilibrium in the body
- helps in keeping the normal temperature of the body
- regulates hydrogen ion concentration in the body
- helps in overcoming diseases by the antibodies contained in the blood

Components of the Cardiovascular System

Heart

Location: middle mediastinal space in the thoracic cavity between the right and the left lungs
Function: muscular organ that pumps blood to all parts of the body

Layers of the heart:

1. **Pericardium** – connective tissue covering
2. **Myocardium** – muscular wall; heart muscle
3. **Endocardium** – smooth innermost wall

Chambers of the heart

- Upper:

1. **Right Atrium** – receives deoxygenated blood from the superior vena cava
2. **Left Atrium** – receives oxygenated blood from the pulmonary veins

-Lower:

1. **Right Ventricles** – receive blood from the right atrium; contract to push blood to the pulmonary artery
2. **Left Ventricles** – receive oxygenated blood from the left atrium; contact to push blood to the aorta

Valves of the Heart

1. **Tricuspid Valve** – with three cusps; separates the right atrium from the right ventricle

2. **Bicuspid Valve or Mitral Valve** – has two cusps; separates the left atrium from the left ventricle; ensures unidirectional flow of blood to the left ventricle

3. **Semilunar valve** – found in the aorta and pulmonary arteries; ensures unidirectional flow of blood to these vessels and to prevent backflow of blood to ventricles

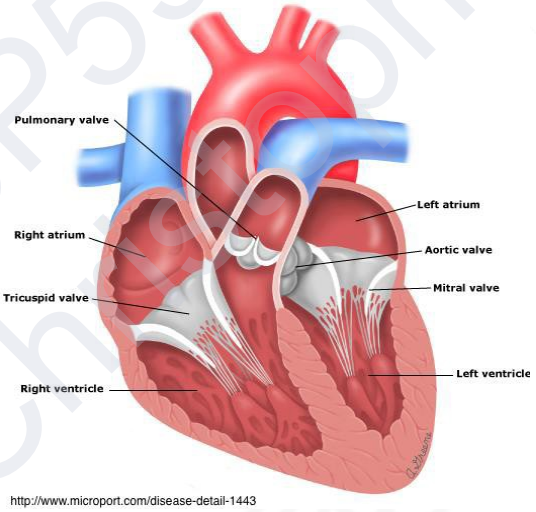
Cardiac Cycle

- the atrial contraction and ventricular contraction
- Systole (contraction), Diastole (relaxation)
- As the atria contracts, blood is pushed to the ventricles
- When the ventricles contract, blood is pushed to the arteries
- All of these events occur in one heartbeat
- These contraction and relaxation create heart sounds

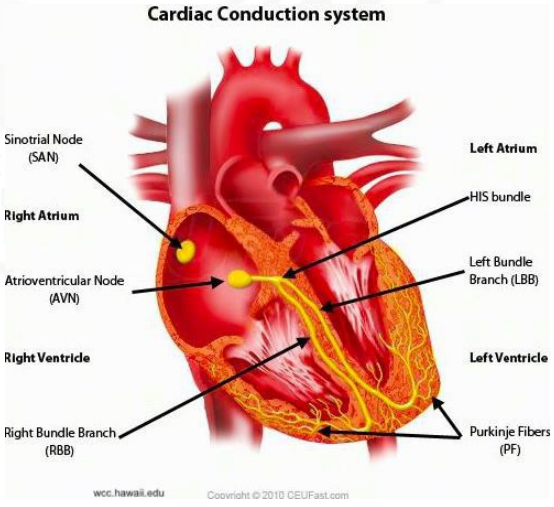
Sino-atrial Node (SA Node)

- Cardiac pacemaker
- rate of discharge determines the rate at which the heart beats

Heart Sounds or Heat Beat



http://www.microport.com/disease-detail-1443



- **Lub** - first sound caused by the closure of the mitral and tricuspid valves

Species	Pulse rate/minute	Location
Chicken	200-400	Auscultation method using stethoscope at the chest region
Pig	70-120	Auscultation method using stethoscope at the chest region
Horse	38	External maxillary artery; about the middle of the lower jaw
Goat	78	Femoral artery
Cattle and carabao	54	External maxillary artery slightly on the outer surface of the lower jaw, and at the coccygeal artery at the base of the underneath of the tail

- **Dub** - second sound caused by the closure of the aortic and pulmonary valves

Sequence:

1. Atrial systole - contraction of atria
2. Ventricular systole - contraction of ventricles
3. Diastole - relaxation of heart muscles

Pulse or Pulse Wave

- the arterial palpation of a heartbeat is determined to measure the rate of heartbeat

Blood vessels

Artery

- Carries oxygenated blood away from the heart to all organ-systems of the body except the pulmonary artery that carries deoxygenated blood to the lungs
- **Arterioles** – small arteries
- **Pulmonary artery** – carries unoxygenated blood from the right ventricle to the lungs
- **Pulmonary veins** – carry oxygenated blood from the lungs to the left atrium of the heart

Veins

- Carry deoxygenated blood from all organ-systems, except the pulmonary vein that carries oxygenated blood from the lungs to the heart
- Equipped with valves to prevent backflow of blood
- Venules – small veins

Capillaries

- Made of a single-layered wall of endothelial cells
- Site of exchange of materials between the surrounding tissues

Blood Circulation

Types of Blood Circulation

Systematic

Blood flows from the lungs to the left atrium, then to the left ventricle and to the aorta that distributes blood to the arteries and the capillaries of the different organs, and back to the heart through the venules and the veins that carry blood to the right atrium

- **Coronary** – supplies blood to the **heart**
- **Hepatic** – supplies blood to the **liver**
- **Cerebral** – supplies blood to the **brain**
- **Renal** – supplies blood to the **kidneys**
- **Splanchnic** – supplies blood to the **digestive tract**

Pulmonary

Carries deoxygenated blood from the heart to the lungs and returns oxygenated blood back to the heart.

Blood

- A thick suspension of cellular elements in an aqueous solution of electrolytes and some non-electrolytes
- Composition: blood cells (erythrocytes or RBC and leukocytes or WBC), blood plasma, platelets and other dissolved substances

Characteristics of blood

- red in color
- pH ranges from pH 7.35 to 7.45
- three to five times thicker (viscous) than water

Plasma

- the fluid portion of the blood that contains blood cells, plasma proteins, hormones and respiratory gases (oxygen and carbon dioxide), metabolic wastes and electrolytes
- makes up to 52%-62% of the total volume of blood
- is 91% water
- normal volume is about 3%-5% of the body weight

The Three Blood Cells

1. **Red blood cells (Erythrocytes)**
   - Biconcave disks manufactured in the bone marrow
   - Packed red blood cells is referred to as Hematocrit
   - Carries oxygen to all parts of the body

   Hemoglobin –protein in red blood cells containing iron responsible for its oxygen-carrying capacity

2. **White blood cells (Leukocytes)**
   - Involved in defense against infection and cancer
   - Classified into three:
     1. **Granulocytes** (neutrophils, eosinophils, basophils) – most numerous; main function is to phagocyte
     2. **Monocytes** – large and non-nuclear; actively phagocytic
     3. **Lymphocytes** – mostly formed in the lymph nodes, spleen and thymus; produce antibodies and counteract toxins

3. **Thrombocytes (Platelets)**
   - produced from cytoplasmic fragmentation of large cell megakaryocyte
   - essential for blood clotting

Lymphatic System

- a network of tissues and organs that help rid the body of toxins, waste and other unwanted materials
  - composed of lymph nodes, lymph vessels and lymph carries fluid from the tissue space into the blood

System	Structure	Function
Reproductive	Ovary, uterus, testes, ducts	Reproduction through production of ova and sperm, and conveyance of sperms to the female reproductive tract for fertilization and pregnancy
Endocrine	Ductless glands	Production of hormones
Nervous	Brain, spinal cord and nerves	Coordination and integration of the functions through relay of information to and from the body
Circulatory	Heart, arteries, veins, capillaries	Distribution of blood and its constituents
Integumentary	Skin, accessory organs	Protection, aesthetics and sensation
Sensory	Eye, ear, nose, skin	Reception of external stimuli

- a defense mechanism by way of transporting lymph, a fluid containing infection-fighting white blood cells throughout the body

Lymph Nodes

- - Ovoid or bean-shaped tissues located in strategic points of the body where lymph passes on its way to the bloodstream
- Functions: produce lymphocytes and stop foreign materials that come to them; become swollen or inflamed during severe bacterial infections

Lymph Vessels

- A system of vessels draining from the lungs and from the rest of the body tissues, ending in the venous system
- Also contains valves that prevent the back flow of its contents (like the veins)

Lymph

- an interstitial fluid derived largely from the blood and in similar composition with blood plasma
- flow in the lymph vessels is unidirectional, from the tissues toward the heart

VI. RESPIRATORY SYSTEM

- the structure involved in the exchange of gases between the blood and the lungs and other organ systems
- an air pump that draws fresh air through the air tubes to smaller air sacs
- 2 major functions:
  - supplies oxygen to the blood
  - removes carbon dioxide from the blood

Parts

1. **Nose**
   - the external nares (nostrils) are the external openings of the respiratory tract

2. **Paranasal Sinuses**
   - air-filled cavities found in cranial bones that provide protection and insulation to the head

3. **Pharynx**
   - common passage of food and air
   - openings of the pharynx include two caudal nares, two auditory tubes from the middle ears, oral cavity, larynx and esophagus

4. **Larynx**
   - the **gatekeeper** to the entrance of the trachea
   - regulates the size of the airway and protects it by closing to prevent substances other than air from entering the trachea

- organ of phonation, hence, the name **voice box**

5. **Trachea and Bronchi**
   - extends from the caudal end of the larynx to the bronchi
   - divides into two principal bronchi
   - principal bronchi branch into secondary, then tertiary; subsequent branches become smaller and smaller
   - when the diameter is less than 1mm, the airways are called Bronchioles
   - eventually branches into alveolar ducts
   - terminates in a cluster of air sacs called alveoli, where the exchange of gases with the blood occurs

6. **Lungs**
   - pair of spongy, air-filled organs located on each side of the chest
   - the medial aspect of each lung features an indentation called hilus where the principal bronchi, pulmonary vessels, lymphatics and nerves enter and leave the lung
   - lobes of the lungs are defined by the presence of secondary bronchi

7. **Pleura**
   - thin tissue layer covering of the lungs
   - they expand and contract during breathing

Respiration

- involves **inspiration**, where the oxygen from the environment is taken in, and **expiration**, where carbon dioxide, a metabolic product, is expelled
- the surface of the pleura is lubricated with serous fluid which allows the lungs to slip smoothly

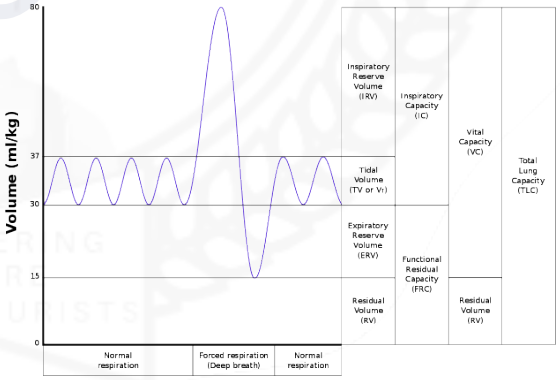
Eupnea – normal, quiet respiration
Dyspnea – difficult breathing
Apnea – cessation/stopping of respiration
Hyperpnea – increased rate/depth of breathing, or both
Polypnea – rapid, shallow breathing

Normal ranges of respiratory rate per minute

Diaphragm – separates the abdominal and the thoracic cavities, which contains the lungs and the mediastinal organs

Vital Capacity

- maximum volume of air an animal can expel from its lungs after maximum inhalation
- function of inspiratory reserve volume, tidal volume, expiratory reserve volume



VII. DIGESTIVE SYSTEM

Prehension – the seizing and conveying of feed into the mouth

Mastication – chewing
- the mechanical breakdown of feed into finer particles
- - importance: finely divided feed presents a greater surface area for the action of digestive enzymes and it allows the feed to be well-mixed with the saliva to facilitate swallowing

Insalivation – the mixing of feed with saliva
- greatest during feeding, mastication or re-mastication in ruminants. Saliva lubricates the feed bolus and adds small amounts of amylase.

Digestion – the mechanical breakdown of feed and the consequent chemical changes brought about by digestive juices, bacteria and protozoa
- includes mechanical, chemical and enzymatic processes

Enzymes – complex proteins produced in living cells that cause changes in other substances within the body without being changed themselves (organic catalysts)

Species	Respiration rate per minute
Fowl	15 - 30
Pig	29 - 33
Horse	27 - 28
Sheep	35 - 38
Cattle	27 - 28
Carabao	24 - 27

Saliva

Salivary amylase – starch to maltose; begins the initial digestion of sugars and starches

Species	Prehensile organ
Cattle	Tongue and lower incisor (dental pad
Horse	Lips and teeth
Sheep	Lips and teeth (dental pad)
Pig	Teeth
Horse	Teeth

Rumen

1. **Cellulase** – cellulose to volatile fatty acids
2. **Amylase** – starch to volatile fatty acids and lactic acid
3. **Protease** – protein to amino acids and NH_3
4. **Urease** – urea to CO_2 and NH_3

Stomach, Abomasum and Proventriculus: pepsin polypeptides

Pancreas – secretes into the duodenum
- **Trypsin** – protein to peptides and amino acids
- **Chymotrypsin** – protein to peptides and amino acids
- **Carboxypeptidase** – protein to peptides and amino acids

Mechanical digestion - the physical breaking down of food into smaller particles to increase the surface area for chemical digestion and mixing food and secretions

Chemical digestion - the breaking down of large molecules that cannot be absorbed, into smaller pieces that can be taken into the body; usually accomplished by enzymes

Absorption – transfer of substance from gastro-intestinal tract (GIT) to the circulatory system (blood, or lymph)

- Once the nutrients are small enough, these are taken into the body by active or passive processes. The materials are absorbed and then passed into the blood stream where they can be distributed throughout the body.

Parts of the Digestive System

1. Mouth and buccal cavity

- for prehension, mastication and insalivation
- used in bolus formation in ruminants
- with 3 accessory organs:
  1. **tongue** – grasping food
  2. **teeth** – mastication of food
  3. **salivary glands** – produce saliva that contains water to moisten food, mucin to lubricate food for easy swallowing, bicarbonate salts to bugger (regulate pH), salivary amylase to start carbohydrate digestion

2. Pharynx

- common passage for air and feed: the inspired air crosses the pharynx to enter the larynx while the feed crosses the pharynx to enter the esophagus

3. Esophagus

- a muscular tube that connects the stomach to the mouth, allows passage of food from mouth to stomach

4. Stomach

- a muscular organ which is the site for feed storage, grinding and mixing, absorption, enzymatic action and microbial fermentation

▶ 3 major functions:

1. storage of ingested feed
2. mechanical breakdown of feed
3. production of HCl enzyme and mucus

5. Small intestine

- has 3 divisions

1. **Duodenum** – active site of digestion
   - receives secretions from the pancreas and intestinal walls
2. **Jejunum** – middle section involved in nutrient absorption
3. **Ileum** – last section, also involved in nutrient absorption

Digestion in the small intestine is enhanced by:

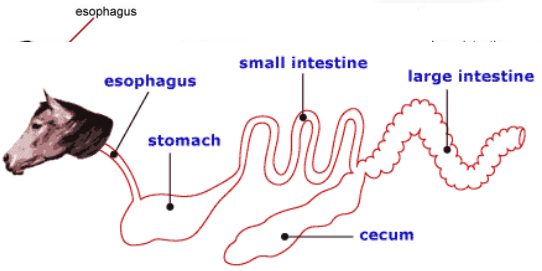
- **Proteolytic enzymes** continue protein hydrolysis
- **Pancreatic amylase** converts starch to maltose
- **Peptidase enzymes** reduce dipeptides to single amino acids
- **Bile** is produced by the liver and stored and secreted by the gall bladder (absent in the horse). Bile aids digestion in the small intestine by emulsifying fat particles.

6. Large intestine

- has 3 sections

1. **Cecum** – first section that is relatively large in the horse and rabbit; contains many bacteria that produce enzymes that digest fiber

2. **Colon** – middle section that is involved in reabsorption of water; length is related to amount of water reabsorption i.e., the colon in very



long in the desert rat

3. **Rectum**
   - last section
   - The last stages of chemical digestion occur in the large intestine through bacterial action; no enzymes are secreted by the colon
   - Bacteria ferment any remaining carbohydrates and release hydrogen, carbon dioxide and methane
   - Bacteria also convert the remaining proteins to amino acids and simpler substances
   - Some vitamins are synthesized by bacteria, including some B vitamins and Vitamin K
   - The large intestine absorbs water, electrolytes and vitamins
   - The chyle has become feces which consists of water, inorganic salts, epithelial cells, bacteria and undigested food

V. Accessory glands

- **Pancreas** - produces digestive enzyme needed in the digestive processes that take place in the small intestine
- **Liver** – secretes bile needed for the emulsification of fat in the small intestine

Types of Animal Based on Stomach Structure

1. **Monogastric**
   - simple stomached, one compartment stomach
   - includes swine and horses
   - digestive pathway:

     mouth - esophagus - simple stomach - small intestine (duodenum, jejunum, ileum) - large intestine (and cecum) - rectum - anus

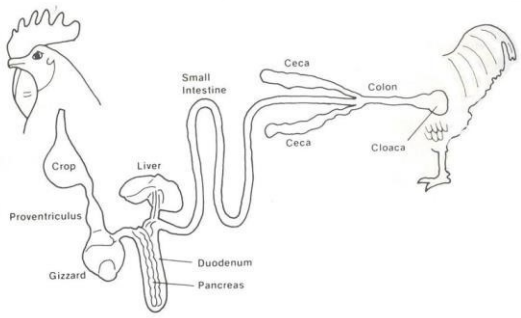
   - in horses, the large intestine, especially the cecum, is highly developed, which allows microbes to flourish (similar to the reticulo- rumen of ruminants) and for most of the digestion of forages to occur

2. **Herbivorous monogastic**
   - horses and rabbits; characterized by enlarged cecum which allows for the microbial fermentation of plant materials

3. **Modified simple stomach**
   - digestive tract of poultry species, with the following modifications: gizzard, crop and proventriculus

- digestive pathway: mouth - esophagus - crop - proventriculus (stomach) - gizzard - small intestine – large intestine (and ceca) - cloaca – vent

The Avian GI Tract



Mouth – does not contain teeth, but beak is used to collect particles of feed and break some large particles into smaller pieces; a tongue and salivary glands are present and the saliva contains salivary amylase

Esophagus – in most birds, includes an enlarged area called crop as a temporary storage and moistening of food, as a place for salivary amylase to work and microbial fermentation to occur in some species

Proventriculus – corresponds to the true stomach; the site of HCl and pepsin production in the bird

Gizzard/Ventriculus – a muscular organ that contains grit; the involuntary muscular contraction aids in the mechanical breakdown of food

Absorption

- active transport; 90% occurs in the small intestine

Carbohydrates are absorbed by facilitated diffusion or active transport

Proteins are absorbed by active transport, mostly in the duodenum and jejunum

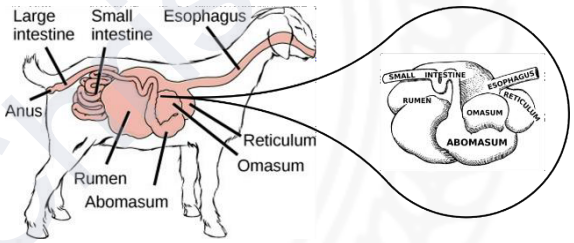
Lipids are absorbed by simple diffusion

Water is reabsorbed by osmosis

Vitamins:

- **fat soluble** vitamins are included in micelles and absorbed by simple diffusion
- **water-soluble** vitamins are absorbed by simple diffusion
- B12 is actively reabsorbed

Parts of the Ruminant GI Tract



Rumen

- Large muscular compartment that fills the left side of body cavity; the largest of the four compartments
- Covered by projections called papillae which are required for the absorption of nutrients
- Main site of microbial fermentation of feeds; the muscular walls secrete no enzymes
- Three major benefits of microbial fermentation:
  1. Conversion of cellulose from vegetative materials to **volatile fatty acids** as sources of energy

2. Production of **microbial protein** from feed proteins and non-protein nitrogen sources that provide the essential amino acids
3. Synthesis of **Vitamin K** and the **B-vitamins**

Functions of Rumen

- provides favorable environment for protozoa and bacteria
- these bacteria are responsible for pregastric fermentation which produces:
  - enzymes that breakdown fiber, starch and protein
  - water-soluble vitamins and Vitamin K
- bacterial synthesis of amino acids and protein
- storage
- soaking
- physical mixing and breakdown

Functions of Rumen Microorganisms

- enable ruminants to utilize fiber
- synthesize AA and CHON from non-protein N
- synthesize all water-soluble vitamins including Vitamin K

Favorable Conditions Provided in the Rumen

- Anaerobic environment
- Constant warm temperature
- Moisture
- Constant food supply
- Mixing

Reticulum

- moves food from the rumen to the omasum
- collects dense particles of food and helps regurgitate ingesta during rumination (chewing the cud)
- regulates the passage of feed from the rumen to the succeeding compartments
- aids in the regurgitation of feed back to the mouth
- a site of microbial fermentation

Omasum

- round muscular organ that contains many muscular laminae (sometimes called manyplies)
- possible functions:
  - controls the passage of ingesta to lower tract (acts as pump), reduces particle size of ingesta and absorption

Abomasum

- very similar to the true gastric stomach
- general characteristics are identical to the gastric stomach of non-ruminants

Additional Unique Features of Ruminants

Esophageal Groove

- begins at the base of the esophagus and when stimulated by sucking, forms a tube that empties into the abomasum
- function: directs milk obtained from sucking to escape microbial digestion in the rumen

Rumination

- the process that permits an animal to forage and ingest feed rapidly, then complete chewing at a latter time; feed in the stomach is regurgitated, reinsalivated and reswallowed; controlled vomiting/contractions of the esophagus, reticulum and rumen allow

ingesta to be regurgitated back up to the esophagus where fluids are swallowed again and additional remastication and reswallowing of solids occur.

Eructation (belching of gas)

- allows for removal of large volumes of gas produced in the rumen; contractions of the upper part of the rumen force the gas up the esophagus and from there, the gas penetrates into the trachea and lungs

VIII. EXCRETORY SYSTEM

Functions

- excretion of waste products (urine)
- regulation of water balance, pH, osmotic pressure, electrolyte level and substance concentration
- several parts of the body that are involved in this process: sweat glands, the liver, the lungs and the kidney system

Kidneys - paired, bean-shaped organs composed of over million units of **nephron**

- regulate concentration of metabolic wastes, osmotic pressure, fluid volume and ionic composition of internal environment
- aid in keeping the composition of blood plasma constant
- excretion of urea and other nitrogenous waste products
- elimination of excess inorganic salts
- elimination of excess water
- elimination of non-volatile, soluble, foreign substances that entered the blood
- regulate the concentration of water and soluble substances like sodium salts by filtering the blood, reabsorbing what is needed and excreting the rest as urine.

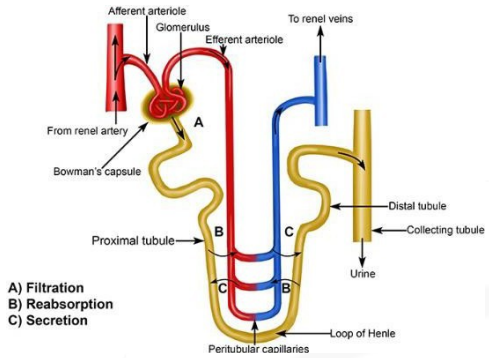
Nephron

- Glomerulus – filter small solutes from the blood
- Proximal Tubule – reabsorbs ions, water, and nutrients; removes toxins and adjusts filtrate pH
- Descending Loop of Henle – allows water to pass from the filtrate to the interstitial fluid
- Ascending Loop of Henle – reabsorbs Na+ and Cl- from the filtrate into the interstitial fluid
- Distal Tubule – secretes and absorbs different ions to maintain blood pH and electrolyte balance
- Collecting duct – reabsorbs solutes and water from the filtrate

IX. REPRODUCTIVE SYSTEM

Functions

- essential for the perpetuation of species to prevent extinction
- produces egg and sperm cells
- transports and sustain these cells
- nurtures the developing offspring
- produces hormones



Male Reproductive System and its Functions

1. **Testis**
   - Paired primary sex organ of the male
   - Functions:
     - ▶ production of sperm
     - ▶ secretion of the male sex hormone testosterone
     - ▶ secretion of androgen
   - in birds, it is located within the body cavity
   - in mammals, it is located in the scrotum, outside the abdominal cavity

2. **Scrotum**
   - External covering of the testes
   - Protects testes from direct mechanical injuries
   - Provides the testes with an environment which is a few degrees cooler than the body temperature

3. **Excurrent Ducts**

   3.1 **Epididymis**
   - Long convoluted tube that connects the vasa efferentia of the testis with the ductus deferens
   - Place for maturation of spermatozoa before ejaculation

   3.2 **Ductus Deferens** (Vas deferens)
   - Muscular tube that merges with the epididymis
   - Propels the spermatozoa from epididymis to the ejaculatory duct in the urethra

   3.3 **Urethra**
   - Canal starting from the junction of the ampulla and ends at the opening of the penis
     - ▶ Common passage of semen and urine

4. **Accessory Sex Glands/Organs**

   4.1 **Ampulla**
   - Temporary storage of sperm until ejaculation

   4.2 **Seminal Vesicles**
   - Produce a secretion high in fructose that acts as vehicle for sperm transport

   4.3 **Prostate Gland**
   - Produces a viscous secretion which stimulates sperm activity and gives the semen its characteristic odor

   4.4 **Cowper's Gland**
   - a small paired gland located on either side of the pelvic urethra

5. **Penis**
   - Erectile tissue whose main function is to drain the urinary bladder of urine
   - Organ of erection and ejaculation

- Serves to introduce spermatozoa into the vagina

Semen – consists of sperm cells and the secretions of the accessory glands

- 14 days in chickens – lifespan of spermatozoa in the female reproductive tract

Female Reproductive System

The female has an immobile haploid gamete (sex cell) called ovum

1. **Ovary**
   - Principal sex organ
   - Paired, almond shaped organ situated near the uterine horn just behind the kidney
   - Functions: Produces the ova and secretes female sex hormone (estrogen)

2. **Infundibulum**
   - Portion of uterine tube adjacent to the ovary whose expanded form is like a funnel-shaped structure
   - Picks up the egg when released by ovary at the time of ovulation

3. **Oviduct or Fallopian Tube**
   - Conducts the ova from each ovary to the respective horn of the uterus
   - Site of fertilization and site of early embryonic development
     - ▶ Passage way of the egg on its way to the uterus

4. **Uterus**
   - Tubular structure extending from the termination of fallopian tubes to the point where the horn of the uterus joins the body of the uterus and continues to the cervix
   - Site of implantation for the fertilized egg and serves in a nutritive and productive capacity for the developing embryo

5. **Cervix**
   - Neck of the uterus
   - Passage way of semen
   - Protects uterus from foreign material
   - During pregnancy, secretes sticky mucus seal

6. **Vagina**
   - Tube extending from the cervix down to the vulva
   - Primary organ of copulation
   - Receives the penis in copulation
   - Provides passageway for the fully developed fetus during parturition

7. **Vulva**
   - Serves the common passageway for the products of reproduction and urine

8. **Clitoris**
   - a rudimentary organ situated ventrally to the vulva; homologous to the glans penis in the male

Puberty and Estrous Cycle

Puberty
- Indicates that the female has reached sexual maturity-capable of producing offspring
- The first manifestation to indicate that the female animal reached the age of puberty is when it starts to show the sign of estrus

Estrus
- Period of sexual receptivity in the female

Estrous Cycle
- the period fom one estrus to the next
- the interval from the beginning of one heat period (estrus) to the start of another heat period
- divided into four stages

Age of puberty, estrous cycle, duration of heat and sperm production in some farm animals

Species	Puberty (months)	Estrous cycle (days)	Duration of Heat (hrs)	Sperm production Vol (mL)	Million/mL
Cattle	8-12	21	12-18	2- 10	300-2,000
Sheep	5- 8	15-17	24-36	0.7- 2	2,000-5,000
Goat	4- 8	19-20	34-39	0.6- 1	2,000-3,500
Swine	4- 8	20-21	48-72	150-500	25- 300
Horse	12-24	19-23	90-172	30-300	30- 800
Chicken	4- 5			0.2- 1.5	0.5- 60

Classification of Animal Based on Occurrence of Estrus

Monoestrus
- Animals that have only one estrous cycle per year
- Example: Wolves

Polyestrus
- Animals that come in heat throughout the year
- Examples: Cattle, swine and carabao

Seasonally polyestrus
- Animals that come in heat at certain seasons only
- Example: Sheep

Stages:

1. **Proestrus**
   - the building-up phase
   - characterized by follicular growth
   - the ovarian follicle enlarges and begins to secrete estrogen

2. **Estrus**
   - period of sexual receptivity
   - ranges from 12 hours to several days
   - influence of estrogen
   - primarily initiated by the elevation in estrogen from mature follicles just prior to ovulation

3. **Metestrus**
   - CL formation to produce progesterone

4. **Diestrus**
   - CL is highly active in producing progesterone

Signs of Heat or Estrus
- reddening and swelling of the vulva
- mucous discharge from the vagina
- frequent urination
- restlessness and lack of appetite
- mounting animals in the herd
- female stands still when mounted by male

Gamete longevity (hours)

Gamete longevity (hours)	Cattle	Horse	Sheep	Swine
Sperm	30-48	72-120	30-48	34-72
Ovum	2024	6-8	16-24	8-10

When to breed or inseminate

- at the time that ovulation would likely take place, or as close as possible to the expected ovulation time.
- too early insemination reduces conception rate due to the loss of sperm viability
- the best time to inseminate is towards the end of estrus
- The duration of estrus is variable. When observed that the animal is in heat, inseminate right away.

Cow

Length of Estrous Cycle

- Heifer - averages 20 days
- Mature cow - 21 to 22 days

Length of Estrus

- Standing heat averages about 18 hours in both dairy and beef cows, somewhat less in heifers. The normal range is 12 to 24 hours.
- Ovulation normally occurs about 10 to 14 hours after the end of estrus in the cow

When to breed

- For artificial insemination, cows that come into standing heat in the morning are bred the same afternoon, and cows that come into standing heat in the afternoon are bred the next morning

Sow

Length of Estrous Cycle

- average estrous cycle is about 21 days, with a range of 18 to 24 days considered normal

Length of Estrus

- estrous period may range from 15 to 96 hours, with an average between 40 and 46 hours

When to breed

- The best time to breed or inseminate is on the 2nd day and third day of estrus

Mare

Length of Estrous Cycle

- average lengths are about 21 to 22 days

Length of Estrus

- average length of estrus is approximately 6 or 7 days

When to breed or inseminate

- recommended on the fourth and fifth day of estrus

Sperm capacitation

- the sperm cells reside in the female reproductive tract before becoming capable of attaching to and penetrating the ovum
- believed to start in the uterus

Fertilization

- the process in which a sperm fuses with an ovum to form a zygote

Zygote

- a fertilized cell in which the genetic materials of the sperm and ovum are combined

Animal	Onset of Puberty	Age of First Service	Estrous Cycle	Estrus	Gestation
Mare	18 mo	2–3 yr	21 d	6 d	336 d
Cow	1–2 yr	1–2 yr	21 d	18 hr	282 d
Ewe	8 mo	1–1.5 yr	17 d	1–2 d	150 d
Sow	7 mo	8–10 mo	21 d	2 d	114 d

Methods of Fertilization

External fertilization - both parents expel their gametes into another medium, such as water, without necessarily coming into contact with each other

Internal fertilization - the male deposits sperm inside the female reproductive tract.

Oviparity - The embryo formed inside the female is deposited outside her body as an egg. After development, offspring hatches out of the egg and directly into the environment. All birds and some reptiles are oviparous.

Ovoviviparity: The embryo develops inside the female body, although it still obtains all nourishment from the egg yolk. The young hatches fully developed and is released from the female's body. Many reptiles and some fish are ovoviviparous.

Viviparity: The embryo develops inside the female's body and the young obtains its nourishment from the female's blood, rather than egg yolk. The young emerges fully developed from the female body. Almost all mammals are viviparous.

Maternal recognition of pregnancy – Implantation allows the conceptus (fertilized egg) and uterine endometrium to achieve intimated contact for nutrient exchange and endocrine communication.

Prostaglandin – causes morphological regression of the corpus luteum and cessation of progesterone production

Placental development – a unique feature of early mammalian development is the provision of nutrients from the maternal organisms by way of placenta

Placenta – fusion of fetal membranes to the endometrium of the uterus to permit physiologic exchange between fetus and mother

- a unique feature of early mammalian development as it allows provision of nutrients from the maternal organism

Gestation – the process of carrying or being carried in the womb between conception and birth

Gestation period – the period of time from conception to birth of the offspring

Hormones of Pregnancy

1. **Progesterone**
   - maintains normal pregnancy
   - provides negative feedback to the hypothalamus to inhibit any further estrous cycles

Frequency of ovulation and length of embryonic development and expected number of progeny per female breeder per year

Species	Estrus	Incubation/Pregnancy, days	Expected no. of young per year
Poultry			
Quail	*	16-19	100-300
Pigeon	*	17	10-20
Chicken	*	21	50-300
Mallard duck	*	28	50-300
Turkey	*	28	50-100
Goose	*	30	20-50
Mucovy duck	*	36	50-100
Rabbit	15-20	32	10-30
Swine	18-24	114	10-25
Sheep	17	147	1-3
Goat	20-21	148	2.5
Cattle	21	280	0.5
Carabao	22-24	316	0.5

- inhibits the smooth muscle of the uterus to permit the attachment and development of the fetus
- assists with maintenance of the contractility of the cervix to protect the uterine environment

2. **Relaxin**
   - dissolution of symphysis pubis and relaxes the pelvic tissues

3. **Prostaglandin**
- induces labor

Parturition – physiologic process by which the pregnant uterus delivers the fetus and placenta from the maternal organisms

Signs of approaching parturition

- Changes in the pelvic ligament
- Enlargement and edema of the vulva
- Enlargement of the mammary gland
- Presence of milk in the mammary gland: a strong indication

Colostrum – the first milk produced upon delivery of the newborn
- important for the survival and vitality of newborn domestic animals
- one of the unique differences between colostrum and typical milk is that colostrum contains a high concentration of **immunoglobulins**
  - immunoglobulins are needed by the neonate to provide temporary immune protection against infectious agents in the environment

X. BODY TEMPERATURE REGULATION

Animal groups based on ability to regulate body temperature with respect to environment:

1. **Homeotherm** (warm blooded) – body temperature is largely independent of that of the environment

2. **Poikilotherm** (cold blooded) – body temperature varies directly with that of the environment

Heat Dissipation

1. **Conduction** – involves direct contact of the animal with a part of its environment

2. **Convection** – heat is transferred to or from the animal by the movement of the heated air particles; posture of the animal and other conditions affecting surface area affect heat convection

3. **Radiation** – transfer of heat by electromagnetic waves; no material medium or physical contact

4. **Vaporization** – the most important process by which animals lose heat to maintain a constant body temperature; heat loss from the skin and respiratory surfaces

Thermal neutrality – body temperature is normal without much regulation; the environmental temperature at which heat loss is equal to minimum heat production

Animal Genetics & Breeding

INTRODUCTION

Breeding – the art and science of the genetic improvement of farm animals

- genetic improvement is effected by the purposeful manipulation of the genetic constitution of animals which determines the expression of their inherent characteristics

Objectives:

- improve the quantity of production of farm animals and their products per unit of time
- improve the efficiency of production of farm animals and of their products
- improve the quality of farm animals and their products
- improve the aesthetic value of farm animals and their products

Genetics – branch of biology that deals with the principles of heredity and variation

Important Contributors to Genetics

- **Gregor Mendel** (1866), the Father of Genetics – an Austrian monk who conducted breeding experiments on garden pea (*Pisum sativum* L.); formulated and published his thesis about the mechanics of inheritance of characteristics in plants; discovered that hereditary characteristics were etermined by elementary factors (genes)

Economically important traits in farm animals

Beef cattle	Dairy cattle	Goat	Sheep	Horse
-post-weaning rate of gain	-milk yield	-multiple births (twinning)	-fleece weight	galloping speed
-marbling score	- butter yield	-weaning weight	-fiber diameter	-trotting speed
	-milk total solids	-milk yield		-jumping style
				-trotting pace length

Chicken – for meat	Chicken - for eggs	Ducks – for eggs	Swine
-growth rate	-egg production	-egg production	-average daily gain
-feed conversion ratio	-egg weight	-egg weight	-litter size
-dressing percentage	-shell thickness	-fertility	-loin eye area
	-haugh unit	-yolk color	-backfat thickness

- **Hugo de Vries** (Netherlands), **Carl Correns** (Germany) and **Erick Von Tshermark** (Austria) – independently rediscovered the works of Mendel in 1901

- **Johannsen** (1909) – a Danish biologist, coined the term "gene" to refer to the particulate factor that Mendel hypothesized as the basic unit of inheritance

- **William Bateson** (1906) – an English biologist who studied the inheritance of certain characteristics of the chicken

- **James Watson** and **Francis Crick** (1956) – young scientists at Cambridge, University of England, hypothesized the chemical nature and function of the gene which is now universally accepted.

Genetic improvement – improvement in the performance of animals brought about by selection assuming that the environment is favorable

Disciplines of Genetics

1. **Mendelian / Classical genetics** – deals with the transmission of genes from generation to generation

2. **Population genetics** – study of heredity in groups of individuals

3. **Quantitative genetics** – study of heredity of traits that could be measured

4. **Molecular genetics** – study of molecular structure and function of genes

DNA

- Deoxyribonucleic Acid; the primary genetic material of all cells
- a biochemical compound consisting of a chain of nucleotides called polynucleotide; each nucleotide consists of phosphate (P), and sugar (S), and a nitrogenous base (B)
- consists of two biopolymer strands coiled around each other to form a double helix

Nitrogen base

- a **nitrogen**-containing molecule that has the same chemical properties as a **base**
- particularly important since they make up the building blocks of DNA and RNA: adenine, guanine, cytosine, thymine and uracil

Base pairs

- pairs of nucleotides connecting the complementary strands of a molecule of DNA consisting of a **purine** linked to a **pyrimidine** by hydrogen bonds

- the **base pairs** are adenine-thymine and guanine-cytosine in DNA, and adenine-uracil and guanine-cytosine in RNA or in hybrid DNA-RNA pairing

Chromosomes

- in the nucleus of each cell, the DNA molecule is packaged into thread-like structures called chromosomes

- made up of DNA tightly coiled many times around proteins called histones that support its structure

Amino acid

- the building blocks of proteins, specific combinations of 3 bases, 20 of which are normally found in proteins and referred to as essential amino acids

Gene

- a segment of DNA that determines the base sequence of nucleotide in the Messenger Ribonucleic Acid (m-RNA) that makes up the code for a certain biological function

- the genetic information that is stored must be such that it can be decoded and translated into action in the developing individual

Property	Mitosis	Meiosis
DNA Replication	Occurs during interphase before mitosis begins.	Occurs during interphase before meiosis begins.
Number of divisions	One	Two
Synapsis of homologous chromosomes	Does not occur.	Occurs along with crossing over between non-sister chromatids in prophase I.
Number of daughter cells and genetic composition	Two diploid (2n) daughter cells that are genetically identical to the parent cell.	4 haploid (n) daughter cells, each containing half as many chromosomes as the parent cell. Daughter cells are genetically different from the parent cell and each other.
Role in the animal body	Produces cells for growth and repair.	Produces gametes and assures genetic diversity in sexual reproduction.

Functions

1. acts as backbone of the chromosome as part of DNA
2. stores and transmits genetic information from cell to cell and from parent to offspring
3. copies or replicates itself with great consistency and precision when new cells are produced
4. synthesizes specific proteins and enzymes (structural genes)
   - ▶ undergoes mutation or error in copying which would subsequently be copied and replicated

How Genetic Information is Transmitted

- The manner by which the genetic information is transmitted from cell to cell is made possible through somatic cell division (mitosis)

- The transmission of the genetic materials from parent to offspring is made possible through reduction division of the germinal cells (meiosis) and subsequent union of the gametes.

Mitosis

- cell division by which the genetic and chromosome composition of a cell is faithfully reproduced in each of the daughter cells

Meiosis

- occurs in preparation for the production of male and female gametes
- consists of two nuclear divisions (Meiosis I and Meiosis II)

Diploid (2n) – two copies of genetic material subdivided into chromosomes

Haploid (n) – one copy of genetic material subdivided into Chromosomes

The G x E interaction

- the mechanics by which the gene is able to synthesize protein in the cell underlies the relationship among the genotype (G) and the environment (E) in the formation of the phenotype (P) of the organism

Chromosome Numbers

Species	2n Chromosomes	No. of pairs
Human	46	23
Cattle, bison	60	30
Sheep	54	27
Swine	38	19
Goat	60	30
Horse	64	32
Donkey	62	31
Mule	63	31+1n
Turkey	82	41
Dog	78	39
Chicken	78	39
Buffalo (swamp)	48	24
Buffalo (riverine)	50	25
Chicken	78	39
Duck (Mallard/Muscovy)	80	40

Phenotypic Expression

- physical expression of a character as affected by genotype (G), the environment (E) and genotype x environment interaction (G x E)

Genotype

- the specific combination of genes that are associated with a particular characteristic of the individual

Environment

- the totality of non-genetic factors affecting the individual

Phenotype

- the observable manifestation of a given character of an individual; the phenotype may change but the genotype remains
- expressed mathematically as P = G + E + (G x E)
  - where G x E is the interaction between the genotype of the individual and the environment under which it is raised

Gene Action

- Gene may be active only when the occur in pairs of allele during the diploid phase

Allele

- one of two or more alternative forms of a gene which are usually recognizable by the phenotype

- during the gametic stage, the cell is in the haploid phase where only one-half of the genetic complement of the organism is contained

- In the gametic phase, the genes are inert. After fertilization, the fertilized egg becomes a diploid cell containing half of the genetic complement of the male and the other half the female parents.

- Soon after fertilization, activation of the genes begin. Not all of the genes become active at the same time.

- Genes that are responsible for growth and development may become active sooner than genes that are responsible for reproduction.

Roles of Genes

Structural genes - directly responsible for the synthesis of certain biochemical products during cell metabolism

Regulator genes - control or regulate the function of other genes; may function in terms of quantity, quality or timing of the activity of certain structural genes

Gene Action

- mode of expression of genes
- action of genes may be detected only from the phenotype
- the action of genes as they influence genotypic values may be any or a combination of the following types:

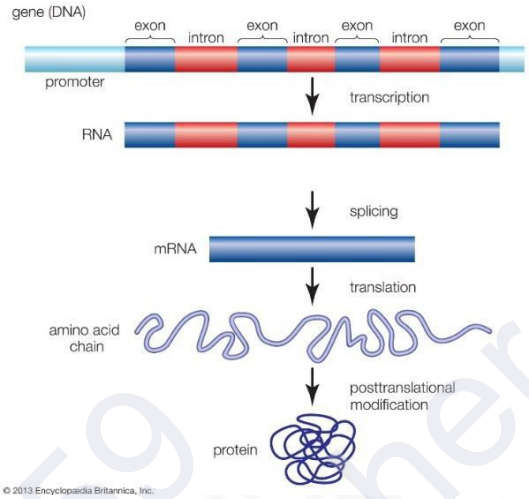
1. **Additive** - the effect of each gene that contributes to the phenotype for a certain trait adds to the phenotypic effect of other genes that contribute something to the same phenotype
   Ex. Skin color in humans

2. **Dominance** - the corresponding trait determined by an allele which is manifested in the heterozygote form
   - a dominant gene suppresses the expression of its allele (recessive)
     Ex. A homozygous pea comb genotype PP) and a single comb (genotype pp) are crossed, the progeny will be heterozygous pea comb (genotype Pp)

3. **Partial dominance** – a gene is not completely dominant to its allele

4. **Lack of dominance** – two alleles are not dominant to each other, and each expresses itself in the phenotype
   Ex. Roan (Red x White) coat color in Shorthorn cattle

5. **Overdominance** – heterozygote is superior in phenotype to the homozygote



6. **Epistasis**
   - taken from a Greek word which means "to stand upon"

   - interaction between two or more genes so that one of them (epistatic gene) interferes with or even inhibits the phenotypic expression of the other gene (hypostatic gene)

I. MECHANICS OF INHERITANCE

Gametogenesis and Fertilization

- the flow of the genetic material from generation to generation is made possible by reproduction
- involves two processes: gametogenesis and fertilization

Gametogenesis – the process of producing the reproductive cells

Spermatogenesis – the process of differentiation of a mature sperm cell from an undifferentiated germ line cell, including meiosis; male produces sperm cells

Oogenesis – the process of differentiation of a mature egg cell from an undifferentiated germ line cell, including meiosis; female produces eggs

Gamete – a mature reproductive cell capable of fusing with a similar cell of the opposite sex to form a zygote; also called sex cell

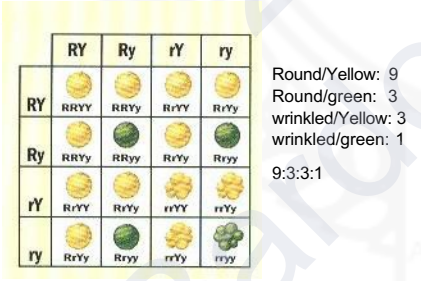
Spermatozoa – the male gamete of animals

Ovum – the female gamete of animals

Fertilization – the fusion of two gametes of opposite sexes to form a zygote or an embryo

Mendelian Inheritance

- Mendelian laws of inheritance are statements about the way certain characteristics are transmitted from one generation to another in an organism.
- The laws were derived by the Austrian monk, **Gregor Mendel**, based on experiments he conducted using pea plants.



- The process of segregation and recombination of genes is governed purely by chance and that the occurrence of each new combination may be predicted according to the rules of probability.

Law of Dominance

- In a cross of parents that are pure for contrasting traits, only one form of the trait will appear in the next generation.
- All the offspring will be heterozygous and express only the dominant trait.
- RR x rr yields all Rr (round seeds)

Law of Segregation and Recombination

- During the formation of gametes (eggs or sperm), the two alleles responsible for a trait separate from each other.
- Alleles for a trait are then "recombined" at fertilization, producing the genotype for the traits of the offspring.

Law of Independent Assortment

- states that genes for the different characters are inherited independently from each other and randomly combine during meiosis
- this law can be illustrated using **dihybrid crosses**
- a breeding experiment that tracks the inheritance of two traits

Dihybrid Cross

1. Traits: Seed shape & Seed color
2. Alleles: R – round
   r – wrinkled
   Y – yellow
   y – green

RrYy x RrYy

RY Ry rY ry RY Ry rY ry

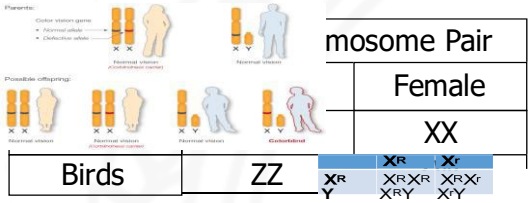
All possible gamete combinations

Non-Mendelian Inheritance

- a general term that refers to any pattern of **inheritance** in which traits do not segregate in accordance with Mendel's laws. These laws describe the **inheritance** of traits linked to single genes on chromosomes in the nucleus.

- also called **quantitative inheritance**

- quantitative traits are controlled by many genes (**polygenic**), each having a



small effect on the expression of the trait

- the relationship among alleles is usually codominance or lack of dominance

- the polygenes increase the value of the trait and are called **additive genes** that cause **additive gene action**, in contrast to dominance and epistasis that cause **nonadditive gene action**

Linkage

– a measure of the tendency of some genes to be inherited as a group rather than individually because of the proximity of their loci in the chromosome

Locus (Loci)

- a place at which a particular gene resides on the genetic or linkage map

Autosomes

- carry genetic material but do not determine sex

Sex chromosomes

- determine the sex of the individual

Types of Sex Chromosome

- Homogametic – there are two of the same chromosomes (ie., XX)
- Heterogametic – that there are two different chromosomes (ie., XY)

Sex Determination

Q: What are the odds of getting a male? A female?
A: 50/50

Sex Linkage

- the phenotypic expression of an allele that is related to the chromosomal sex of an individual

- Since there are far more genes on the X chromosome than the Y, there are far more X-linked traits than Y-linked traits

- In contrast to normal autosomal chromosomes, both sexes do not have the same probability of expressing the trait

- The genes that are present on the X or Y chromosomes are called sex-linked genes. These traits can also be dominant and recessive

- X-linked recessive traits are expressed in all heterogametics, and in homogametics that are homozygous for the recessive allele

- Heterogametics only have one X chromosome, and therefore whatever is there is expressed (ie., it cannot be masked by the other chromosome)

- Homogametics on the other hand must have both chromosomes affected for the X-linked recessive chromosome to have an effect.

Autosomal Linkage
- Genes that are more closely linked tend to be inherited together more often than those that are located further apart in the same chromosome

Non-nuclear Inheritance
- also called "cytoplasmic inheritance"
- inheritance due to the genes located outside the nucleus
- genes located at the cytoplasm (plasmagenes)
- present in the mitochondria and chloroplast
- quite rare in animals

Maternal influence
- other than the genetic materials in the chromosomes and the possibility that there may be genetic materials in the cytoplasm, the mother could further influence the characteristics of her offspring because of the maternal care she provides to her young

II. POPULATION GENETICS

Population
- refers to the total of all individuals of some specified group (i.e., same breed, species, or other subgroupings) living in the same geographical area
- genetic composition of populations are expressed in frequencies

Gene Frequency – refers to the proportion of a gene in a population with a specific allele

Genotypic Frequency – refers to the proportion of the total animals with a particular genotype

Gene pool – the totality of the genes that could potentially be transmitted by individuals in a population to the next generation

Hardy-Weinberg (HW) Equilibrium
- a state when the genetic composition of a population does not change
- gene and genotypic frequencies remain constant from generation to generation
- it is a large population undergoing random mating
- no selection
- no migration
- no mutation
- the principle was independently formulated in 1908 by the British mathematician Hardy and the German physician Weinberg

Factors Affecting the Genetic Composition of a Population

Selection – a process in which certain genotypes contribute more progeny in the next generation than other genotypes

Types of Selection

- **Natural selection** – natural forces, "survival of the fittest"

- **Artificial selection** – imposed by man to improve certain traits
  - increases the frequency of genes associated with the phenotype

Methods of artificial selection

1. **Individual selection** – based on individual merit or performance and is strictly phenotypic
   - used in traits with high heritability

2. **Family selection** – whole families are selected based on mean phenotypic value of the family
   - 2.1 **Sib selection –** selection based on values taken from brothers and sisters
   - 2.2 **Progeny testing** – based on the performance of the individual's progeny
   - 2.3 **Within family selection** – based on the deviation of each individual from the mean of its family
   - 2.4 **Combined selection** – combination based on the family average and individual performance in the family

3. **Pedigree selection** – based on the performance of an individual's ancestry
   - ▶ Used when selecting before the individual expresses the trait
   - ▶ Used in selection based on sex-limited traits
   - ▶ Used in the selection of males prior to progeny test

4. **Independent culling levels** – minimum standards are set for several traits, and failure of an animal to meet the minimum standard for any trait results in its removal from the herd
   - an animal's performance in one trait is entirely independent of its performance in other traits

5. **Selection index** – important traits are evaluated and combined into one figure (score)
   - the weight assigned to each trait depends upon its economic importance, heritability and genetic linkage to other traits, and is combined in an index
   - higher scores mean valuable animals selected for breeding

6. **Tandem selection** – selection for several traits, but one trait is considered at a time until satisfactory improvement is made

Migration - a process in which individuals from one population transfer to another population

- ▶ Example: introduction of new breeds of beef cattle from Europe in US.

- ▶ The change in the genetic composition in the host population after migration is directly proportional to the following factors:

1. the number of migrants in proportion to that of the resulting population after migration

2. the difference in the gene frequencies between the migrants and the natives

Mutation

- a spontaneous change in the base sequence of DNA molecules
  - mutation occurring in the germinal cells could be transmitted to the next generation

1. **Point Mutation** – changes in one or a few nucleotides

2. **Frameshift Mutation** – shifts the reading frame of the genetic message so that the protein may not be able to perform its function

Genetic Drift – a change in gene frequency due to random fluctuations caused by change in mating patterns or sampling errors

- **Small population size** causes genetic drift
- would result in change in the gene frequency simply because of chance variation
- because of certain physical, physiological or psychological factors, some individuals tend to mate more often together than with some other individuals

- **Non-random mating** – occurs when some individuals do not have the same chances of mating with individuals of the opposite sex

▶ **Disassortative** –individuals which are less phenotypically similar tend to mate more often together than would be expected by chance

▶ **Complete disassortative mating** – sex dimorphism in mammals (i.e. the maintenance of male and female sexes) where only the mating between XX and XY genotypes is successful

▶ **Inbreeding** –individuals that are related by descent tend to mate more often than under random mating

Chicken for eggs	Ducks for eggs	Swine	Chicken – for meat
-egg production -egg weight -shell thickness -haugh unit	-egg production -egg weight -fertility -yolk color	-average daily gain -litter size -loin eye area -backfat thickness	-growth rate -feed conversion ratio -dressing percentage

Beef cattle	Dairy cattle	Goat	Sheep	Horse
-post weaning rate of gain -marbling score	-milk yield -butter yield -milk total solids	-multiple births (twinning) -weaning weight -milk yield	-fleece weight -fiber diameter	-galloping speed -trotting speed -jumping style -trotting pace length

Heritability

- estimates how much variation in a phenotypic trait in a population is due to genetic variation among individuals in that population; ranges from 0 to 1

- heritability value of 0 suggests that all the phenotypic variations among individuals in the population are due to environmental and non-additive genetic effects

- a heritability of 1 means that all variations among individuals are only attributable to additive effect of genes

- traits that are associated with reproduction (e.g. fertility, litter size) have lower heritabilities than those associated with physical condition (e.g. body weight and backfat thickness)

Animal Breeding

- the art and science of the **genetic improvement** of farm animals
- can be achieved through:

1. Selection – a process wherein some individuals are chosen to be parents of the next generation. Basis for election:

1.1 physical
1.2 performance records
1.3 Estimated Breeding Values (genetic merit)
1.4 molecular level (genotyping)

2. Appropriate Breeding System

2.1 **Inbreeding** – a form of non-random mating or a special case of assortative mating where individuals that are related by ancestry are mated together

Inbreeding depression – reduction in fitness or vigor because of inbreeding
- traits affected: reproductive traits

2.2 **Outbreeding** – mating of animals that are less closely related

- **Outcrossing** - crossing of two unrelated lines within the same breed (A x A)

- **Crossbreeding** – crossing of two different breeds (A x B)

Heterosis - the average superiority of a crossbred individual over the average of the breeds involved in the cross

- **Upgrading** – crossing a native animal with an exotic breed (Native x A)

- **Species hybridization** – crossing of animals from different species or genera

Pedigree – a record of an individual's ancestry; the ancestral relationships among individuals of a family

III. REPRODUCTIVE AND GENETIC TECHNOLOGIES

Reproductive Biotechnologies

Artificial Insemination (AI) – a process of inducing fertilization without sexual contact between the male and female animals.

Advantages:

1. more rapid genetic improvement through the use of superior sires
2. savings from cost of maintaining a sire for a small herd or flock
3. reduced risk of spreading reproductive and other diseases

Semen evaluation:

1. concentration or density
2. motility
3. morphology

Semen volume, sperm count and potential number of inseminations per ejaculate in some farm animals

Species	Semen Volume(mL)	No. of sperm (Millions/mL)	Potential no. of inseminations/ Ejaculate
Cattle	2- 10	300-2,000	100-600
Sheep	0.7- 2	2,000-5,000	40-100
Goat	0.6- 1	2,000-3,500	15- 40
Swine	150-500	25- 300	15- 20
Horse	30-300	30- 800	8- 12
Chicken	0.2- 1.5	0.5- 60	8- 12
Turkey	0.2- 0.8	0.7	30

Multiple Ovulation and Embryo Transfer (MOET)

- **Multiple ovulation** – a process by which the female animal is induced to simultaneously ovulate more eggs than what is normally shed

- **Embryo transfer** - young embryo is collected from a donor female parent and then implanted into the uterus of a recipient female parent

- **Sperm sexing** – a process where the X-bearing sperm cell is separated from the Y-bearing sperm cell

- **Cloning** – refers to the continued splitting of embryos that would lead to an indefinite duplication of an individual

Animal Nutrition

I. INTRODUCTION

Definition of Terms

Nutrition – the study of various physical and chemical processes that transform food elements to body elements and the influence of various feed additives to various processes in the body

- It involves ingestion, digestion and absorption of various nutrients, their transport to all body cells, metabolism and the removal of unusable nutrients and waste products of metabolism

Feedstuff - any material both natural in origin and synthetically prepared that when properly used have nutritional value in the diet.

- Ex: Corn, DL methionine, feed supplements, some vitamin pre-mixes, etc.

Nutrients - substances or elements found in the diet that are very necessary to support animal life processes. These are carbohydrates, fats, proteins, vitamins, minerals and water.

Ration - the food given to the animals with a balance of nutrients they need within 24 hours; requirement/food allowance

Diet - the kind of food given to animals regardless of whether or not it has a good balance of nutrients they need

Food/Feed - any material that comes naturally in both plants and animals including the by-products prepared from them

Digestion - the process of breaking down food particles through mechanical, enzymatic and/or microbial processes in preparation for absorption

Absorption - the transport of all digested nutrients to all parts of body tissues and cells

Metabolism - the next process of nutrient utilization in the body after it is digested and absorbed in the cells. It is the sum total of all the physical and chemical changes occurring in the body where nutrients are metabolized into energy in the form of ATP, carbon dioxide and water (metabolic water)

Metabolic water - the water produced from the nutrients (carbohydrates, fats and proteins) when metabolized in the cells

II. ESSENTIAL NUTRIENTS

- nutrients that the body cannot synthesize on its own - or can be synthesized but not in adequate amounts and must be provided by the diet.
- necessary for the body to function properly

Six Essential Nutrients

1. Carbohydrates

- very high in plants and negligible in animal tissues
- the major component of animal food, consisting of about 75% of the dry weight of plants which provide energy to animals
- contain carbon (40%), hydrogen (7%) and oxygen (53%)

Classification of Carbohydrates based on the number of sugar molecules

Monosaccharides – simple sugars utilized by the body without undergoing hydrolysis.

- Ex: glucose, galactose, fructose, mannose, xylose
- May be classified based on the number of carbon atoms
  - **Hexoses** – glucose, fructose, galactose, mannose
  - **Pentoses** – arabinose, xylose, ribose
    - ▶ May be classified based on the functional group
      - **Aldose** – with aldehyde functional group
      - **Ketose** – with ketone as functional group

Disaccharides – carbohydrates containing 2 simple sugars that should undergo hydrolysis with specific enzymes before they are absorbed and utilized by the body

- Ex: Maltose, sucrose, lactose

Polysaccharides – contain several simple sugars that should undergo hydrolysis with specific enzymes before they are absorbed and utilized by the body

- Ex: starch, cellulose, glycogen, hemicellulose, gums, pectins, lignin

Starch - glucose units linked by α-linkage

- composed of **amylose** (unbranched) and **amylopectin** (branched)
- principal carbohydrate reserve of plants

Glycogen - major carbohydrate reserves in animals

- stored in liver and muscles

Cellulose - most abundant carbohydrate

- glucose units linked by β-*linkage*
- principal cell wall constituent of plants

Chitin - composed of glucose derivatives (N-acetylglucosamine)

- primary component of fungal cell wall and the exoskeleton of arthropods

Functions in the animal body

1. major source of energy
2. source of heat
3. building stores for other nutrients
4. stored in animal body by converting to fats

2. Fats or Lipids

- present in both plants and animals
- insoluble in water but soluble in ether, benzene and chloroform
- yield fatty acids and glycerol upon hydrolysis
- contain carbon (77%), hydrogen (12%) and oxygen (11%)
- yield 2.25 times more energy than carbohydrates or proteins

Fatty Acids - hydrocarbon chains capped by a carboxyl group (COOH)

1. **Saturated fatty acids** – all carbon skeletons are filled up with hydrogen

2. **Unsaturated fatty acids** – not all carbons are filled up with hydrogen; contain double bonds

Fatty acids found in lipids

Essential Fatty Acids

- fatty acids that humans and other animals must ingest because the body requires but cannot synthesize them and can be obtained from food
  a. Linolenic acid
  b. α-linoneic acid
  - used to build specialized fats called omega-3 and omega-6 fatty acids that are important in the normal functioning of all tissues of the body

Classification of Fats/Lipids

1. **Simple Lipids** - esters of fatty acids and alcohol
2. **Fats and oils** – esters of fatty acids and glycerol
3. **Waxes** – esters of long chain alcohol and fatty acids
4. **Compound lipids** – esters of fatty and alcohol in combination with other compounds
5. **Phospholipids** – major component of all cell membranes
6. generally consists of two hydrophobic fatty acid "tails" and hydrophilic phosphate “head”, joined together by a glycerol molecule
7. phosphate groups can be modified with simple organic molecules
8. **Glycolipids** – lipids that are covalently bonded to monosaccharides or polysaccharides

3. Proteins

- contain carbon (53%), hydrogen (7%) and oxygen (23%), nitrogen (16%), phosphorus (1%)
- act as enzymes, hormones & structural components
- principal constituents of the organs of soft structure of the animal body
- composed of **amino acids**

True protein - composed of amino acids

Non-protein nitrogen (NPN) - contains N but not amino acids

Crude protein - composed of true proteins and non-protein nitrogen (NPN)

- % Crude Protein = %N x 6.25

Amino Acids

- biologically important organic compounds containing amine ($-NH_2$) and carboxylic acid (COOH) functional groups, usually along with a side-chain specific to each amino acid
- about 500 amino acids are known
- as proteins, amino acids comprise the second-largest component of human muscles, cells and other tissues
- perform critical roles in processes such as neurotransmitter transport and biosynthesis

Classification of Amino Acids

1. **Essential** – necessary but the body cannot synthesize, therefore must be supplied in the diet

Phenylalanine	Arginine
Methionine	Tryptophan
Valine	Leucine
Histidine	Isoleucine
Threonine	Lysine

2. **Non-essential** –necessary but the body can synthesize

Alanine	Hydroxyproline
Glutamine	Cysteine
Asparagines	Serin
Glycine	Glutamic Acid
Aspartic Acid	Tyrosine

Functions:

- structural unit of the animal body (collagen, elastin, contractile protein, keratin, blood proteins)
- body metabolism enzymes, hormones, immune antibodies, hereditary transmission

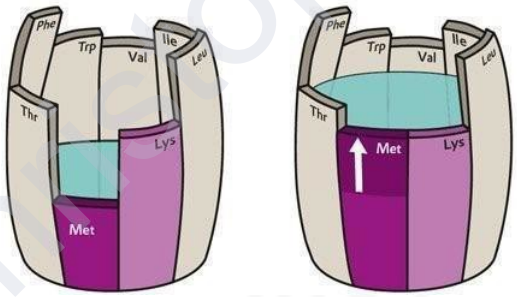
Deficiencies and abnormalities

- Symptom: reduced growth rate and feed efficiency, anorexia, infertility

- Amino acid deficiency – a lack of an important amino acid which results in deamination

Limiting Amino Acid Concept

- The "Liebig barrel" illustrates the limitation of protein synthesis due to the



lack of an essential amino acid. The shortest stave of the barrel represents the first limiting amino acid

The Liebig barrel

Peptide Bond – a chemical bond formed between two amino acids when the carboxyl group of one AA reacts with the amino group of the other AA, releasing a molecule of water

Classification of Proteins

Simple proteins – contain only ordinary amino acids
- Albumin – egg white, blood serum

- Globulins – seed proteins, myosin in muscles and antibodies
- Glutelins – cereal grain proteins
- Prolamins – common in most seeds
- Histones – globin of hemoglobin
- Protamines – nucleic acids; sperm of fish
- Scleroproteins or albuminoids – fibrous proteins like hair/nail proteins

Fibrous proteins – constitute about 30% of total protein in the body
ex. collagen, elastin, keratins

Conjugated proteins – yield other materials aside from amino acids

Phosphoprotein – casein, pepsin (containing phosphorus)

Glycoprotein – gonadotrophic hormones (containing carbohydrates)

Lipoprotein – blood, egg, brain (containing lipids)

Chromoproteins – pigments, enzymes

Nucleoproteins – contain nucleic acids

Minerals

- inorganic elements that are very important to ensure normal body functioning
- the total mineral content of plants or animals is often called ash

Classified into:

Macro-minerals – present at larger levels in the animal body or required in larger amounts in the diet
- include calcium, chlorine, magnesium, phosphorus, potassium, sodium and sulfur

Micro-minerals – often referred to as trace minerals
-present at low levels in the body or required in smaller amounts in the animals diet. Micro-minerals include chromium, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, selenium, and zinc

General functions:

- Skeletal formation and maintenance – Ca, P, Mg, Cu, Mn
- Function in protein synthesis – P, S, Zn
- Oxygen transport – Fe, Cu
- Fluid balance (osmotic pressure) – Na, Cl, K
- Regulating acid-base balance of the entire systems – Na, Cl, K
- Activators and/or components of enzyme systems – Ca, P, Mg, Fe, Cu, Mn, Zn
- Mineral-vitamin relationship – Ca, P, Co, Se

Vitamins

- organic substances essential for the maintenance of health and life, although needed in very minute amounts
- either are not synthesized in the body or are synthesized in inadequate quantities
- most vitamins function as coenzymes or cofactors
- can be classified as fat-soluble and water-soluble vitamins

Fat Soluble Vitamins

- vitamins that are soluble in lipids
- usually absorbed in fat globules
- stored in body tissues
- Vitamin A, Vitamin D, Vitamin E and Vitamin K

Water Soluble Vitamins

- vitamins that dissolve in water

1. Vitamin B1 (Thiamine)
2. Vitamin B2 (Riboflavin)
3. Vitamin B6 (Pyridoxine)
4. Vitamin B12 (Cyanocobalamin)
5. Biotin; Folic Acid
6. Vitamin C (Ascorbic Acid)
7. Pantothenic Acid
8. Niacin (Nicotinic Acid)

Mode of Action

Fat-soluble

1. Vitamin A (Retinol) – development of visual pigments; formation and protection of epithelial tissues, increased resistance
   - sources:
     feeds – provitamin A in green crops; fish liver oil
     food – liver, egg yolk, milk, dairy products
2. Vitamin D (Calciferol) – regulates calcium and phosphorus deposition and absorption
   - sources:
     feeds – sundried greed forage, liver oil
     food – egg, milk, dairy products
3. Vitamin E (Tocopherol) – antioxidant, detoxifying agent
   - sources:
     feeds – green crops, cereal germ, milling by- products
     food – leafy vegetable, some animal organs, milk, butter
4. Vitamin K (Menadione) – blood coagulant, maturation of bone structure
   - sources:
     feeds – green forage, liver oil
     food – green vegetable, potatoes, fruits (tomatoes and strawberry)

Water-soluble

1. Vitamin B_1 (Thiamine) – participate in carbohydrate metabolism
   - sources:
     feeds – cereal germ, milling by-product, oil cakes, yeast
     food – cereal, vegetable, potatoes, fruits, animal organs, egg yolk, milk
2. Vitamin B_2 (Riboflavin) – constituent of flavin enzyme involved in hydrogen transfer
   - sources:
     feeds – oil seeds, yeast, brewery by-products, vegetables, fish meal, meat, bone meal, skimmed milk
     food – liver, kidney, eggs, milk, dairy products
3. Vitamin B_6 (Pyridoxine) – amino acid metabolism; coenzyme
   - sources:
     feeds – grains, milling by-products, oil cakes, yeast
     food – cereals, green vegetables, red meat, liver, egg yolk, milk
3. Vitamin B_{12} (Cyanocobalamin) – reduction of one-carbon

compounds in fat and protein metabolism
- sources:
  feeds – skimmed milk powder, fish and meat meals
  food – liver, kidney, egg yolk

5. Biotin (Vitamin H) – gluconeogenesis and fatty acid synthesis where it acts on carboxylation reactions
   - sources:
     feeds – in partly available form in feeds of vegetable and animal origin
     food – vegetables, yeast, mushrooms, liver, kidney, meat, egg yolk, milk
5. Folic Acid – indispensable in the formation of amino acid and nucleic acids
   - sources:
     feeds – lucerne meal, extracted soybean meal, fish meal
     food – dark leafy vegetables, liver, kidney, muscle
7. Nicotinic Acid (Niacin) – acts as an active group of different coenzymes which are related to the citric acid cycle
   - sources:
     feeds – brans, dried green crops, yeasts, vegetable and animal proteins
     food – liver and meat of hoofed animals
8. Pantothenic Acid – part of coenzyme A, which occupies a central position in the intermediary metabolism by activating weakly active acids
   - sources:
     feeds – dried green crops, milling by-products, oil cakes, yeast

Symptoms Indicative of Marginal or Advanced Vitamin Deficiencies

Poultry

1. Nervous disorders such as convulsion – A, E, B_1, B_2, B_6 and Fol
2. Skin or mouth lesions – A, B_2, B_6, H, PP and Pant
3. Discharge from eyes or swollen,pasty eyelids – A and Pant
4. Reduced resistance to infectious diseases – A, E, B_2, B_6, Pant and C
5. Poor feathering – A, D, B_6, H, Fol, PP and Pant
6. Bone abnormalities – A, D, H, Fol and PP
7. Leg weakness or paralysis – A, D, E, B_2, B_6 and H
8. Reduced egg production – A, D, E, K, B_2, B_6, B_{12}
9. Retarded growth – A, E, K, B_1, B_2, B_6, B_{12}, H, Fol, PP Pant and C
10. Low hatchability – A, D, B_2, B_6, B_{12}, H, Fol and Pant

Pigs

1. Muscular incoordination or other nervous signs – A, D, B_6, B_{12} and Pant
2. Reduced feed intake – A, D, B_1, B_2, B_6, B_{12}, H, Fol, Pant
3. Impaired vision or blindness – A, B_2, B_6
4. Scours and/or vomiting – B_1, B_2, B_6, B_{12}, H and Pant
5. Hair, skin and claw problems – A, B_2, B_6, B_{12}, H and Pant
6. Anemia – E, K, B_6, B_{12}, Fol, PP and Pant

7. Impaired feed conversion – B_1, B_6, B12, H, PP and Pant
8. Lameness or unsteady gait – A, D, E, B2, B6 and Pant
9. Poor reproduction – A, E, B_2, B_{12}, H, Fol
10. Retarded growth – A, D, E, B_1, B_6, B_{12}, H, Fol

Ruminants

1. Muscular incoordination or other nervous signs – A and B
2. Reduced feed intake – A, D and PP
3. Impaired vision or blindness – A
4. Digestive disturbances – A and B_1
5. Rough hair coat – A
6. Degeneration of heart and skeletal muscle – E
7. Poor reproduction – A, D and E
8. Retarded growth – A, D and E
9. Bone deformities or swollen joints – A and D

Water

- cheapest and most abundant nutrient
- regulate the animal's body temperature
- to assist in transporting nutrients
- necessary for most metabolic reactions in the body and is a major component of cells, blood, and body tissues
- found in the animal body as:
  1. Intracellular water – mainly muscles and skins
  2. Extracellular water – mainly interstitial fluids, blood
  3. plasma, lymph, synovial fluid and cerebrospinal fluid
  4. Water present in urinary and gastrointestinal tract

Sources of water

1. Drinking water
2. Water from the feeds
3. Metabolic water

Physiological States requiring Nutrition

1. **Maintenance** – when the animals are neither gaining nor losing weight and does not work, produce product, store fat and develop fetus
2. **Growth** – when tissue synthesis (muscle, bone, organ and some fats) takes place in the young animal
3. **Fattening** – when increased fat deposition becomes desirable (finishing).
4. **Reproduction** – when there is an increased need for nutrients for ova/sperm production, or for fetal development in gestating animals
5. **Lactation** – when the dam must be provided with extra nutrients so that it could produce more milk for her litter without sacrificing her own body reserves
6. **Maintenance**
7. to maintain body weight or size (no gain or loss)
8. to support the essential life processes, i.e. respiration, circulation, normal muscular activity, etc.
9. to maintain body temperature
10. to maintain different body secretions (i.e. hormones)

Growth

- correlated increase in the mass of the body to reach the size at maturity fixed by heredity
- in practical terms, growth is reflected in increased weight and size

- it is characterized by:
  - ▶ increase in number of cells
  - ▶ increase in size of the cells

Protein Requirement for Growth

- High protein level and good protein quality (essential amino acid make-up) are both needed for optimum growth
- Protein requirement gradually lowers with age
  - ▶ for example, hog starter feeds may require more than 20% protein while hog finisher feeds may contain only 14% protein

Energy Requirement for Growth

- Energy (coming mainly from carbohydrates; provided also by fats and proteins) is the driving force for tissue synthesis and anabolism
- Even with adequate amino acids, minerals and vitamins, growth cannot take place at the optimal rate without sufficient energy

Growth Rates and Feed Efficiency

- The practical measures or growth performance of farm animals are average daily gain (ADG) and feed efficiency (F/G). The values are greatly affected by two major factors:
  1. hereditary (particularly the breed or strain of the animal)
  2. environment (particularly by the nutrition and management)

	ADG (kg)	F/G kg feed/kg Liveweight gain
Growing pigs (improved crossbreds)	0.4 – 0.6	2.5 – 3.5
Growing cattle (native)	0.4 – 0.5	11.0 – 12.0
Growing cattle (native-Zebu grades	0.5 – 0.7	10.0 – 11.0
Broiler (modern strains)	1.5 – 1.8 (6-7 weeks)	2.0 – 2.3

Reproduction

- The nutrient requirements for reproduction represent the additional amounts of the various nutrients needed for:
  - ▶ the female's coming into estrus, subsequent conception and adequate development of the fetus until birth
  - ▶ the male's maintenance of the integrity of the reproductive organs and its sperm cells and sex hormones
- Too severe nutrient deficiencies giving rise to low level of fertility are manifested by the following symptoms:
  a. Cessation of estrus
  b. Resorption of fetus
  c. Abortion
  d. Birth of dead or weak young

Milk Production

- Lactation in any species requires substantial nutrients for synthesis of adequate amount of milk to nourish the young
- Dairy type animals produce milk for human consumption and relatively very much less for the nourishment of their young

- Good dairy cows in the temperate countries such as the U.S. yield about 25- 50 kg milk daily
- Relatively good dairy cows in the Philippines and in most of the tropics correspondingly yield only about 8-12 kg daily
- Genetics and climate (direct and indirect effects) have very much to do with this difference
- Milk constituents and blood sources:
  1. Casein - blood amino acids
  2. Immune globulins - blood globulins
  3. Fat - fatty acids; acetate
  4. -Lactose - glucose
  5. Minerals - minerals in blood
  6. Vitamins - vitamins in blood

II. CLASSIFICATION OF FEEDSTUFFS

Different Classification of Feedstuffs

- Roughages
- Concentrates
- Supplements

Roughages

- Feed materials containing more than 18% crude fiber and are generally low in energy
-
- Available in 3 forms:
  1. Dry roughage
  2. Silage
  3. Pasture
- 2 basic types
  1. Grasses
  2. Legumes

a. **Alabang X** (*Dicanthium aristatum*)
b. **Centrosema/Kudzu/Calopogonium** (*Centrosema pubescens*)
c. **Guinea grass** (*Panicum maximum*)
d. **Ipil-ipil** (*Leucaena leucocephala*)
e. **Kakawate/Madre de cacao** (*Gliricidia sepium*)
f. **Napier grass** (*Pennisetum purpureum*)
g. **Para grass** (*Brachiaria mutica*)
h. **Star grass** (*Cynodon plectostachyus*)
i. Rice straw
j. Corn stover
k. Setaria

Concentrates

- Feeds high in energy (NFE and TDN) and low in crude fiber (less than 18%)
- Two Types of Concentrate:
  1. Basal or Energy Feeds
  2. Protein Feeds

Basal or Energy Feeds

- generally characterized by high in energy (TDN, ME)
- -low in fiber (less than 18%)
- low in protein (less than 20%) – protein quality is variable and generally quite low
  - ▶ Cereal grains (corn, sorghum, feed wheat)
  - ▶ Mill by-products (rice bran, wheat pollard, corn bran, corn gluten feed, dried whey, molasses)
  - ▶ Fats/oils (vegetable oils & animal fats)

Protein Feeds

- contain more than 20% protein
- have two origins:

1. Animal Origin Protein Feeds

- ▶ generally high-quality protein feeds
- ▶ derived from meat packing or rendering plants, surplus milk or milk products, and from marine sources
- ▶ this group of feeds are used to improve the total protein of basal feeds
  - Ex. Fish meal, Meat and bone meal, Skim milk powder

2. Plant Origin Protein Feeds

- ▶ include the common oil seed by-products
- ▶ vary in protein content and feeding value depending on the seed from which they are produced, the amount of hull and/or seed coat included and the method of oil extraction used
  - Ex. Soybean oil meal, peanut meal, corn gluten meal, brewer's dried grain, copra meal, etc.

Supplements

- feedstuff mixed with a primary grain and/or roughage to provide all the nutrients required to support the form of production for which it is intended
  - Ex. Mineral supplements, vitamin supplements, amino acid supplements, feed additives

Mineral Supplements

- rich sources of one or more of the inorganic elements needed to perform certain essential body function
  1. Limestone – source of calcium
  2. Oyster Shell – source of calcium
  3. Salt (table salt) – source of Na & Cl
  4. Tricalcium Phosphate – source of calcium & phosphorus

Vitamin Supplements

- rich synthetic or natural feed sources of one or more of the complex organic compounds called vitamins
  - Ex. Fat Soluble Vitamins, B-Complex Vitamins, Vitamin C

Feed Additives

- Substances of non-nutritive nature which, when added to feed, will improve feed efficiency and/or production of animals
  - Ex. Antibiotics, drugs, antioxidants, enzymes, flavoring agents, mold inhibitors, toxin binders, probiotics

Banana meal
Bloodmeal
Bonemeal
Cassava meal
Coconut oil
Copra meal
Corn grain
Dicalcium phosphate
Dl-methionine
Fish meal
Limestone
L-lysine

Meat and bone meal
Molasses
Monodicalcium phosphate
Oyster shell
Rice bran
Salt
Sorghum
Soybean oil meal
Skimmilk
Tricalcium phosphate
Urea
Wheat pollard/Wheat bran
Whey

IV. RATION FORMULATION

- the process of quantifying the amounts of feed ingredients that need to be combined to form a diet that supplies all of an animal's nutrient requirements

Methods of Ration Formulation

Trial and Error Method
-although time consuming, consideration is given to all nutrients

Pearson Square Method
- simple & easy method of determining the correct proportion of two feed ingredients or two feed groups to obtain a desired level of protein
- only the protein content of the ration is given major consideration

Sample Problem (Pearson Square)

A farmer wishes to mix a ration containing 14% Crude Protein (CP). He decided to use yellow corn with 8.5% CP and fish meal with 65% CP. How much of each of the feed ingredients should be used?

General steps in feed formulation

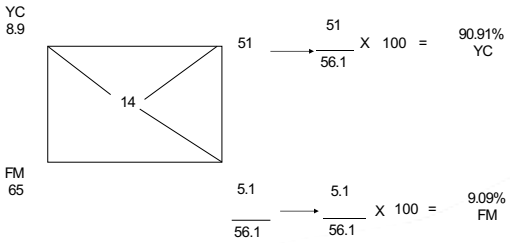
1. Know the particular species and class of animal for which a ration is intended
2. Determine the nutrient requirements of animals
3. Identify feeds to be used in feed formulation. Consider the availability and unit price.
4. Be acquainted with the nutrient composition of the feeds to be used
5. Decide on a suitable combination of feeds that results to a good ration

Important considerations in feed formulation

1. Nutrient requirements
2. Palatability
3. Economical
4. Digestibility
5. Presence of anti-nutritional factors

Feed evaluation and quality control

- **Proximate analysis/Weende analysis** – the most extensively used method of determining the nutritive value of feeds; includes the following analysis in:
  1. **Moisture** – determined by accurately weighing finely ground sample before and after drying to constant weight at 105°C for at least 5 hours
  2. **Crude fat** – a residue that includes all ether-soluble substances such as waxes, essential oils and pigments but is mostly fat and fatty acid esters



3. **-Crude fiber** – a rough measure of the portion of carbohydrates poorly used by monogastric animals
4. **Crude protein** – the total nitrogen multiplied by a factor 6.25 based on the data that protein contains an average of 16% nitrogen
5. **Ash** – the residue remaining after combustion

Animal Products and Processing

INTRODUCTION

Meat and Meat Products

Definition of Terms

Meat – properly dressed flesh derived from mature animals in good condition at the time of slaughter.

Meat of different animals

- **Beef** – ox, one year old and above
- **Veal** – ox, less than one year old
- **Carabeef** – carabao beef, caraveal
- **Chevon** – goat
- **Game meat** – game animals (wild hunted)
- **Horsemeat** – horse
- **Lamb** – sheep, less than one year old
- **Mutton** – sheep, one year old and above
- **Pork** – pig
- **Venison** – deer

Carcass – the body of any slaughtered animal after bleeding and dressing

Dressing percentage – percent yield of the carcass, carcass weight divided by the slaughter weight multiplied by 100

Fresh meat – meat from an animal that has not undergone any substantial physical, microbiological and chemical change from the time of change

Wholesale cuts – meat cuts that are handled in bulk and usually require further cutting before these are prepared for the table

Retail Cuts – cuts of meat handled in small quantities and which may be prepared for the table without further cutting and trimming

Rigor Mortis – the stiffening of the muscles after an animal dies, believed to be due to muscle contraction

Hot meat – meat from an unaccredited slaughterhouse, or obtained from illegal source

Slaughtering – from fasting through stunning, bleeding up to skinning and evisceration

Butchering – from splitting and quartering, to cutting the carcass into the retail cuts

Abattoir or slaughterhouse – the premises used in the slaughter of animals for human consumption

Sex

- Barrows and gifts have no distinct differences in meat quality
- Boar taint odor is only apparent in uncastrated male after reaching 7 months of age. Thus, a less than 7 month-old boar is fit for slaughter.
- Meats from castrated hogs are fatter than their female and uncastrated male counterparts of the same age
- Meat from pregnant animal is low in quality. The meat may be fishy in odor when the animal is at an advanced stage of pregnancy.
- In cattle, meat from bull is generally less tender and lower in overall acceptability than that of steers

Age

- Recommended for swine is 6 to 12 months, 3 years of younger for cattle and carabao, and about a year for goats
- Meat from older animals tends to become darker, tougher, fatter and poorer in quality than meat from younger animals. However, it is flavorful, has a high water binding and emulsion capacity which is associated with high degree of marbling.
- The most important quality factor which changes with age is tenderness
- In general, meat from young animals is juicier than meat from old ones
- Pork follows the same trend as beef. Very little change in tenderness occurs after 11 months of age.

Health

- Only healthy animals should be considered for slaughter. However, those with minimal defects can also be slaughtered when they pass the anti-morterm inspection.
- Unhealthy animals must first be treated to become normal prior to slaughter. Meat from unhealthy animals is poor in quality and is not recommended.

Meat Yield

- The average dressing percentage of swine in the Philippines, head off is about 69% and the total trimmed lean cuts amount to 36% of the live weight
- Beef and carabeef have similar average dressing percentage of 48% but differ in the total lean yield with 34% and 33% respectively
- Goats have 43% dressing percentage and 27% total lean yield

Loin Eye and other Measurements

- Wide loin eye area in swine is indicative of high lean cut and low fat cut yields
- Slaughter hogs with wide loin area are ideal for slaughtering

Fatness

- Consumers discriminate fatty meat. However, fat greatly influences flavor, tenderness and juiciness.

- For comminuted beef and pork products, 30 to 40% fat seems to be the most acceptable in terms of flavor, tenderness, juiciness and overall acceptability

I. MANAGEMENT PRIOR TO SLAUGHTER

Fasting

- Feed is withdrawn but sufficient water is given
- Pigs being simple stomach animals are fasted for 12-24 hours while carabaos and cattle being ruminants are fasted for 24-48 hours

Advantages of fasting:

1. savings on feed
2. ease of cleaning entrails
3. ease of cleaning and eviscerating carcass
4. a thoroughly bled and brightly colored carcass
5. long shelf-life
6. low shrinkage of the resulting meat

Stress - the animal should not be subjected to any form of stress prior to slaughter (shipping stress, over- crowding stress, driving stress, heat stress and others)

Disadvantages of stress:

1. loss of muscle glycogen
2. high temperature of carcass
3. low water binding capacity of meat
4. low aroma, flavor, texture and juiciness scores
5. meat from stressed animals is not recommended for curing
6. the condition of the meat is pale, soft, and exudative (PSE) if the stress is not severe and it becomes dry, firm and dark (DFD) when the stress is severe

Mishandling

- Blood clots develop in the part of an animal whipped, kicked or boxed prior to slaughter due to the breaking of some blood vessels in the affected areas
- Meat with blood clots and red spots are not good materials for processing because they always spoil before the curing period is completed

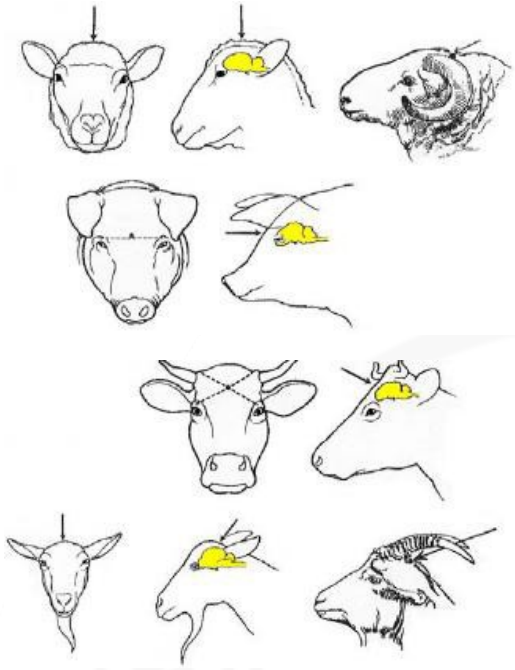
Slaughtering Guidelines

- Set by the National Meat Inspection Service (NMIS), formerly National Meat Inspection Commission
- Provide the minimum set of equipment and the standard features of a slaughterhouse

Classification of Slaughterhouses in the Philippines

1. **AAA** - with adequate facilities and operational procedure and the meat processed therein is eligible for sale in any market in and out of the country
2. - **AA** - with facilities and operational procedures sufficiently adequate and the meat processed therein is eligible for sale in any market in the Philippines

3. **A** - with facilities and operational procedure of minimum adequacy and the meat processed therein is eligible



Areas targeted during stunning

for sale only in the city or municipality where the plant is located

Basic Requirements

1. cleanliness of the meat produced
2. hygiene of production
3. efficiency of meat inspection
4. the adequacy of meat preservation

I. GENERAL STEPS IN SLAUGHTERING AND ANTE-MORTEM INSPECTION

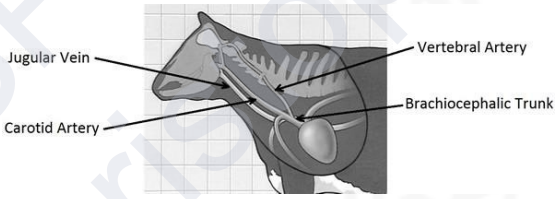
- conducted by a qualified meat inspector to determine whether the animal is fit for slaughter or not
- accepts only animals that are healthful, safe from harmful chemical and drug residues, and capable of being converted into wholesome product

Stunning

- rendering the animal unconscious without killing them to make the restraining easy and sticking humane

Sticking

- withdrawing blood from the carcass; cautioned not to pierce the heart that may cause instant death of the animal and will thoroughly prevent bleeding; efficiently cutting the carotid artery or the jugular vein not later than 3-5 minutes after stunning



Location of the jugular vein and the carotid artery

Cleaning of the Carcass

- includes scalding, scraping, shaving, flaying, dehiding

Eviscerating
- removing visceral organs from the carcass

Splitting
- cutting of the entire backbone of the carcass

Washing
- with clean potable water to remove dirt, blood, etc.

Slaughtering Procedures

In Swine

Ante mortem inspection – Stunning – Sticking – (cleaning) Scalding and Scraping – Removal of Head – evisceration – splitting – washing – post mortem inspection (12-24 hrs)

- **Scalding** – dipping the carcass in hot water to loosen up hairs and scarf; the water temperature must be maintained at 54 to 84ºC; too hot water can cause hair setting while too cold water cannot effect loosening of hairs and scarf
- **Scraping** – removal of hair using a scraping knife

In Cattle and Carabaos

Ante mortem inspection – Stunning – Sticking – (cleaning) Flaying – Removal of head – evisceration – splitting – washing – post mortem inspection – chilling (36-48 hrs)

- **Flaying or Skinning** – the removal of the hide
- **Shrouding** – wrapping the carcass with cheesecloth. The cloth is soaked in lukewarm water and wrapped around the carcass while it is warm. The cloth absorbs the remaining blood at the surface of the carcass, smoothens the internal fat covering, causes fat to appear white and dense and prevents excessive shrinkage and oxidation.

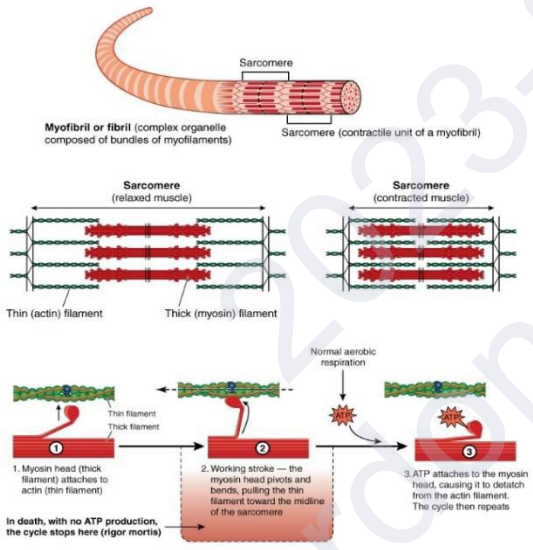
In Goats

There are two methods of slaughtering goats – the singed method and the flayed method

- **Singed Method** – after stunning and sticking, singeing is done with either a blow torch or an open fire. While singeing, the hairs are continuously scraped with a dull knife until the hairs are all burned. The belly must be pinched to avoid bursting of the

whole belly cavity. After singeing, the canked skin is sliced off for the preparation of Kilawin. Evisceration is done similar with that in cattle.

- **Flayed Method** – the process of stunning and sticking in the singed method is followed, but the skin is not utilized for food. The removal of fleece or flaying is made slightly different from that in cattle and carabao. Be sure not to allow the meat to come in contact with hairs to avoid imparting goat odor to the meat. Evisceration and chilling in goats are similar with that in cattle except that in goats, splitting of the carcass is not done.



IV. POST-MORTEM INSPECTION

- done by a qualified meat inspector to determine if the meat is fit for human consumption or not

Inspected and passed: the carcasses so marked have been found to be sound, healthful, wholesome and fit for human consumption

Passed for sterilization: carcasses or parts of carcasses so marked inspected and passed for food, subject to the condition that these must be sterilized by steaming in an appropriate apparatus or by boiling in an open kettle

Inspected and condemned: carcasses or parts of carcasses so marked are unsound, unhealthful, unwholesome or unfit for human consumption; those unfit for both human and animal are denatured with strong chemical disinfectants prior to final disposal

Passed for rendering: carcasses or parts of carcasses that may be converted into animal feed

Chilling: the carcass is chilled at 0-4ºC for 24 hours before fabrication to allow the rigor mortis to pass, to check on microbial growth, and to firm up the meat for easy fabrication

"Rigor Mortis" – natural stiffening of muscles from dead animals due to the locking of actin-myosin chains inside muscle tissues. Causes tough meat even after cooking.

V. MEAT FABRICATION AND MEAT PRODUCTS

Meat Fabrication

- cutting carcasses into standard wholesale and retail cuts
- proper fabrication lowers of cutting losses
- Basic principle: Separate tender meat from tough meat because they require different methods of cooking.
- the cheap parts are separated from the expensive parts

Meat and Meat Products

Brand – any mark or stamp approved by the controlling authority

Carcass – the body of any slaughtered animal after bleeding and dressing

Dressing percentage – percent yield of the carcass, carcass weight divided by the slaughter weight multiplied by 100

Finish – the amount, character and distribution of fat in the carcass

Fresh meat – meat from an animal that has not undergone any substantial physical, microbiological and chemical change from the time of slaughter

Greening – formation of green color in the skin and other collagenous tissues as a result of excess nitrite; may also be due to microbial action

Green hams – uncured smoked hams

Green weight – weight of a cut of meat in its fresh state before curing or processing

HACCP – Hazard Analysis Critical Control points the fat granules

Hot boned meat – meat deboned before the development of *rigor mortis*

Hot meat – meat from an unaccredited slaughterhouse, or obtained from illegal source of meat

Loin eye area – the cross sectional area of the longissimus dorsi muscle of pork/beef

Lean cuts – cuts of pork composed of the loin, ham and shoulder

Meat – properly dressed flesh derived from mature animals in good condition at the time of slaughter

Retail cuts – cuts of meat handled in small quantities and which may be prepared for the table without further cutting and trimming

Rigor mortis – the stiffening of the muscles after an animal dies, believed to be due to muscle contraction

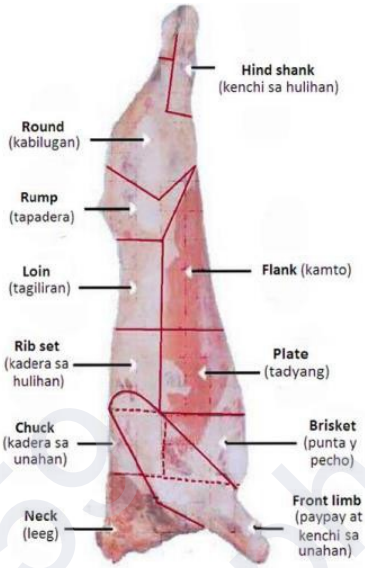
Wholesale cuts – meat cuts that are handled in bulk and usually require further cutting before these are prepared for the table

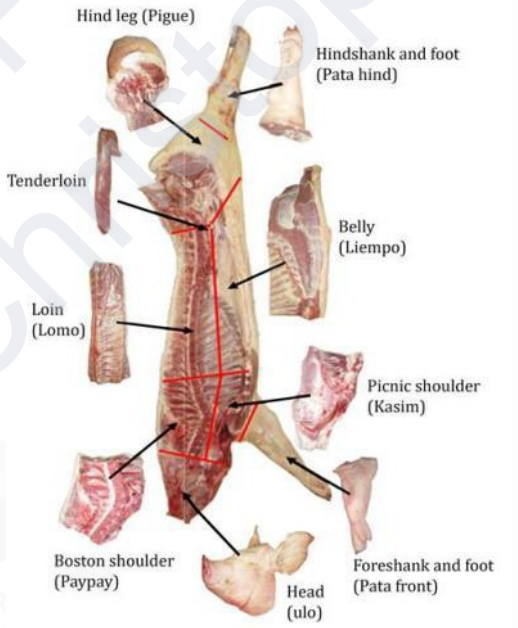
Primal or wholesale cuts of beef

- Neck
- Chuck
- Rib set

- Loin
- Rump
- Round
- Hind shank
- Flank
- Plate
- Brisket
- Front limb

Source: Philippine National Standard – Beef Primal Cuts





Retail cuts of beef

- **Chuck**
  - Blade pot roast
  - Arm pot roast
  - Rolled chuck roast

- **Rib set**
  - Standing rib roast
  - Rolled rib roast
  - Rib steak
  - Short rib
  - Rib eye steak

- **Round**
  - Sirloin tip/knuckle tip steak
  - Standing rump roast
  - Rolled rump roast
  - Round roast/steak
  - Bottom round roast/steak
  - Top round roast/steak
  - Heel of the round
  - Cross cut shank
  - Ground beef/round

- **Flank**
  - Rolled flank
  - Flank stew
  - Flank steak
  - Flank steak fillet

- **Plate**
  - Short rib
  - Plate stew
  - Rolled beef plate

- **Brisket**
  - Brisket stew

Primal or wholesale cuts of pork

- Boston shoulder
- Loin

- Tenderloin
- Hind leg
- Hindshank and foot
- Belly
- Picnic shoulder
- Foreshank and foot
- Head

Retail cuts of pork

- **Ham**
  - Ham butt rose
  - Shank half roast
  - Butt ham roast/slice
  - Center ham roast/slice
  - Shank ham roast/slice
  - Boneless ham

Source: Philippine National Standard – Pork Primal Cuts

- **Shoulder**
  - Boston butt
    - boston butt roast/slice
    - rolled boston butt
  - Picnic
    - picnic or arm roast
    - picnic slice or arm steak
- **Loin**
  - Blade loin roast (3rd to 9th rib)
  - Center loin roast (10th to 2nd lumbar)
  - Sirloin roast (3rd lumbar to 3rd sacral)
  - Blade chop
  - Center loin chop
  - Sirloin or loin chop
- **Belly**
  - Bacon slab
  - Bacon slice
  - Spare ribs

Retail cuts of poultry

- Breast
- Thigh
- Drumstick
- Back
- Wings
- Neck
- Feet
- Giblets
  - Gizzard
  - Liver
  - Heart

Meat Composition

- Contains lean, fat, bones, connective tissues and other similar elements
- The lean is the most important part of meat in relation to human nutrition
- Meat protein has high biological value. It can supply the essential nutrients needed for normal growth and physiological function of human adults without being fortified
- Meat also contains sufficient B-vitamins, phosphorus, iron and potassium but deficient in calcium

Meat of Different Animals

Beef – meat of mature cattle, cherry pink to dark red
Veal – meat of young cattle, pinkish brown
Carabeef – meat of carabao, darker than beef
Mutton – meat of mature sheep, bright red/brick red
Lamb – meat of a young sheep, light pink
Chevon – meat of a goat, bright red paler than mutton
Venison – meat of a deer

Pork – meat of a hog/swine, whitish gray/pale red/gray pink
Rabbit meat – meat of a rabbit, white
Poultry meat – meat of avian species i.e. chicken, turkey, goose, duck, quail, guinea fowl, etc.

VI. MEAT PROCESSING

- Modifying meat in order to improve its taste and/or extend its shelf life

Chilling – to firm up the meat and check on the growth of microorganisms (2-4°C for 24 hrs)
Trimming – removes excess fat, parts with blood clots and bruises' includes deboning when necessary
Weighing, Washing and Dripping

Methods of Meat Preservation

1. **Moisture control**
   - 1.1 **Drying** – the removal of moisture from the meat, either by natural/sun drying or by artificial drying at a temperature of 110°F- 120°F
   - 1.2 **Smoking** – the process of subjecting meat to the action of smoke and heat generated by burning hardwood or sawdust
     - Cooking, flavoring and preserving meat by exposing it to smoke
     - can be accomplished by natural or artificial method
       - 1.2.1 **Natural** - the exposure of meat to wood smoke which causes the deposition of pyroligneous acid on the meat surface that acts as preservative and flavoring agent
       - 1.2.2 **Artificial** - smoke flavor is incorporated in the meat
   - 1.3 **Salting** –accomplished with the addition of common table salt
   - 1.4 **Freeze drying** – the removal of moisture from the tissue by sublimation or the transformation of the moisture content into ice and gas without passing the liquid state
   - 1.5 **Curing** – the application of salt, sugar, salitre and other preservatives and adjuncts to prolong the keeping quality of meat
2. **Thermal control**
   - 2.1 **Refrigeration** – the exposure of meat to a temperature of 36°F-50°F to retard mold and bacterial growth for a limited period
   - 2.2 **Freezing** – the exposure of meat to a temperature range of 0°F-32°F or -18°C-0°C, resulting in the crystallization of water in the tissues, thus inactivating the enzymes and bacteria present
3. **Thermal processing**
   - 3.1 **Cooking** – subjecting meat to a high temperature to kill pathogenic microorganisms
   - 3.2 **Canning** – the hermetic or airtight sealing of food in cans or jars using 212°F or 100°C and 10-15 pounds of pressure for specific periods of time
   - 3.3 **Irradiation** – the transfer of extremely large amount of energy

to effect very rapid and selective biological and chemical changes in meat

4. **Use of chemical preservatives**
   - 4.1 **Salt** – the addition of salt causes an increase in osmotic pressure thereby withdrawing moisture from the meat, making it detrimental to the growth of microorganisms
     - salting is a simple method of dehydration in which the salt causes the withdrawal of water from the tissue of both the meat spoilage organisms, resulting in the shriveling and inactivation of the cells
   - 4.2 **Sugar** – using high percentages of sugar increases osmotic pressure, thereby withdrawing moisture. It also reduces the pH of meat due to carbohydrate fermentation.
   - 4.3 **Acids** – acetic acid lowers pH of meat, hence reducing microorganisms. It also helps tenderize meat.
   - 4.4 **Nitrates (NO_3)** – at certain levels, potassium nitrate has bacterial effect. Otherwise, they are only bacteriostatic.
   - 4.5 **Benzoates** – reduces growth of molds in sausages at 0.1% level
   - 4.6 **Spices** – certain spices have inhibition effect on microorganisms

Curing

- the application of salt, sugar, salitre (potassium nitrate) and other preservatives to prolong the keeping quality of the product
- Sugar, spices, vinegar and wine may be used for different types of cure, but in small quantities and, thus, may have no preservative effect

Curing Ingredients and Their Functions

Salt

- the primary ingredient used in curing
- a good preservative and provides the most desirable flavor
- causes the dehydration of the tissues through osmosis, and withdraws water from the protoplasm of the spoilage organisms, shriveling and inactivating their cells
  - ▶ it improves the ability of the meat protein to retain either the normal moisture content or added water and stabilize the fat-protein emulsion in sausages
  - ▶ there are 3 kinds of salt available locally: the solar or coarse salt, the fine or "Pangasinan" salt and the industrial or refined salt
  - ▶ recommended amount is 2.5%-3.0% of the total meat volume

Sugar

- a secondary ingredient in curing
- counteracts the astringent quality of salt, enhances the flavor of the product and aids in lowering the pH of the cure
- Refined cane sugar is most suitable. The use of brown sugar is limited by the fact that it caramelizes at lower temperature and tends to darken the meat on cooking.
- Large amounts of sugar on prolonged curing promote microbial g0rowth,

which usually causes acid fermentation that affects palatability and color.

Nitrates and Nitrites

- potassium nitrate and sodium nitrate: color fixation agents, responsible for the development of the proper color in cured meat products
- nitrates and nitrites have a pronounced effect on flavor
- further effect flavor by acting as powerful antioxidants
- very effective inhibitors of the growth of Clostridia
- must be used with caution during curing because they are poisonous: strict limits on their use have been established

Phosphates

- increase the water-holding and binding capacity of cured products
- With increased water-holding capacity, product yields increase, product surfaces are drier and firmer and emulsions are more stable at higher temperatures
- not easily soluble in brine, should be dissolved in water first before they are added to the brine
- use is restricted to 1 tsp. dissolved in 1/4 cup of water per kilogram of meat

Benzoates

- reduce growth of molds in sausages at 0.1% level

Acetic acid

- i.e. vinegar, calamansi juice lower the pH of meat, reducing microorganisms
- added for flavor
- has some antiseptic value that aids in prolonging the shelf-life of the finished product
- the acetic acid content should be between 4.5% to 5.0%

Spices

- defined by Food and Drug Administration as "aromatic vegetable substances used for seasoning of food"
- enhance palatability of meat
- consist of leaves flowers, buds, fruits, seeds, barks, rhizomes, or other plant parts which have been dried (pepper, onion, garlic, ginger, paprika, laurel, oregano)
- there are spices produce selective inhibition of microorganisms i.e. cloves inhibit microorganisms due to a substance called eugonol

Monosodium Glutamate (MSG)

- has no flavor of its own when in purified form, but merely enhances the natural flavor of the product in which it is added
- warning: too much of MSG may cause dizziness, nausea and headache, commonly called "Chinese Restaurant Syndrome"
- MSG should not exceed 1/2 tsp or 2.0 grams per kilogram of meat

Coloring agents

- color is a very important attribute of meat and is subject to great changes during processing
- often required to make meat products attractive to the consumer

Binders, Fillers and Extenders

Binders – proteinaceous agents that improve water-binding properties of comminuted meat products i.e. sodium caseinate-90% protein, soy protein isolate-90% protein, wheat gluten-80% protein, soy protein concentrate-70% protein

Fillers – carbohydrate products that absorb extensive quantities of water i.e. cereal flour, starches

Extenders – these are non-meat materials added in the amount that they are able to increase the bulk or modify the quality of sausage or meat loaf products
- usually plant proteins

Meat, Milk and Egg Production

I. SWINE PRODUCTION

Swine Production Terms

Barrow – a male swine, castrated (testicles removed) before it reaches sexual maturity

Boar – mature male swine usually kept for breeding

Sow – an adult female usually kept for breeding and has farrowed at least once

Creep – a separate area of a farrowing pen accessible only to young, suckling pig and not their dams

- High protein, palatable feed for the piglets up to weaning is provided in the creep area

Docking – removal of a portion of the tail by cutting to minimize tail biting among pigs

Dry sow – dry sow that is not milking; an unbred or a non-pregnant female

Farrow – to give birth to young pigs

Farrowing – the act of giving birth in swine

Gilt – a young female swine usually kept for breeding and one that has not yet given birth

Litter – a group of pigs belonging to one gestating sow; refers to the offspring at one birth of a multiparous animal like swine

Litter interval – the period from the birth of one litter to the birth of the succeeding litter. This is sometimes referred to as farrowing interval.

Littermate – one of the piglets in a litter in relation to the other pigs belonging to the same gestation

Primiparous sow - a female that has farrowed only once. It is sometimes referred to as a young sow

Multiparous sow - a female which has farrowed 2 or more litters and sometimes referred to as old sow

Parity - the number of litters a sow or gilt has had

Open sow - a sow whose litter has been weaned but which has not yet been bred or is not pregnant. Good breeding efficiency depends on low numbers of open sows in the herd.

Stag - a male swine, castrated after sexual maturity

Weanling - a young pig of either sex which has been separated from the mother at the end of the lactation period

Pork - fresh meat as flesh of swine

Zoological Scheme

KINGDOM:	Animalia
PHYLUM:	Chordata
CLASS :	Mammalia
ORDER:	Artiodactyla
FAMILY:	Suidae
GENUS:	*Sus*
SPECIES:	*Scrofa/vittatus*
SUB-SPECIES:	*domesticus*

Sus scrofa **–** a wild hog of continental Europe from which most domestic swine have been derived

Sus vittatus –the chief, if not the only species of the East Indian pig that contributed to domestic swine

Breeds of Swine

Breed – a group of animals of common origin that possess certain true distinguishable characteristics that make them different from other members of their species

Philippine Native Pig

- indigenous animals belonging to a large undefined population of individuals without any uniform traits usually ascribed to a breed.
- The local pig or Philippine Native pig belongs to this category, as they are
- small and lack the anatomical symmetry of standard breeds.
- General characteristics: Small and late maturing, mostly solid black or black and white have small ears; sway back and with weak pasterns.
- Other Scientific Names:
  1. Luzon Warty pig *Sus philippinensis*
  2. Palawan Bearded pig *Sus barbatus*

Common Breeds

Landrace

Origin: developed in Denmark for the production of high quality bacon

Characteristics: white in color, although black skin spots or freckles are common

- known as the longest breed of swine (16 to 17 ribs)
- known for its prolificacy and mothering ability under Philippine conditions

Disadvantage: Weak legs and pasterns especially on the hind leg. Some strains of Landrace have narrow body and long legs depending on the country of origin.

York Shire/Large White

Origin: an English bacon breed which had its origin in Yorkshire and neighboring countries in Northern England. It was developed by selection and crossing with Leicester hog which was a white hog.

- The present Large White was developed in England

Characteristics: Yorkshire should be entirely white in color

- Yorkshire sows are noted as good mothers (Mother Breed).
- not only farrow or raise large litters, but are great milkers

Disadvantage: Some individuals are relatively short and with big belly and tend to have excess back fat

Duroc

Origin: originated in the eastern United States and in the Corn Belt

Characteristics: has solid colors, ranging from very high light golden to very dark red that approaches the color of mahogany

Performance: considered a superior breed in terms of growth rate and feed efficiency; has a good muscle quality and is probably the most resistant to stress

Disadvantage: some individuals tend to have unsound front and hind legs that may lead to stiff gilt or lameness

Pietrain

Origin: Pietrain, Belgium, the village from which the breed takes its name

Characteristics: may be appropriately called the "muscle" pig because of its outstanding muscle development in the ham, loin and shoulder

- backfat is very thin; mothering ability is well within acceptable level

Disadvantage: Because of the relatively well-muscled ham, the number one problem of this breed is usually weakness of the hind legs, which do not develop as fast as the ham muscle.

- also known for being a slow grower and being highly susceptible to stress

Hampshire

Origin: traces its origin to Southern England

Characteristics: Its most striking characteristic is the white belt around the shoulder and body including the foreleg

Performance: Feed efficiency, length and ham-loin percent of this breed is excellent

Disadvantage: Low litter size at birth and at weaning, poor mothering ability and late maturing. Being black is also an objection because it is associated with thick backfat.

Berkshire

Origin: South Central England, principally in the countries of Berkshire and Wiltshire

Characteristics: Short and sometimes upturned nose; black in color with 6 white points; four white feet, one point on the forehead, and another on the switch of the tail

Disadvantage – has a small litter size at birth and at weaning, late maturing, with thick backfat and the black skin

Poland China

Origin: South-western Ohio in the fertile area known as the Miami Valley

Characteristics: Black in color with 6 distinct white points: the four feet, poll of the head and switch of the tail

Upgrades

1. **Diani** – upgrade of native pigs (Batangas) with Berkshire

2. **Kaman** – upgrade of native pig (Batangas) with Duroc

3. **Berkjala** – 5/8 Berkshire and 38 Jalajala pig (Rizal)

4. **Miracle Pig** – ½ Large White, ¼ Landrace and ¼ Native

Hybrid or Synthetic Breeds

- do not have distinguishing physical characteristics which differentiate them from other group of pigs
- a result of a combination of the good characteristic traits of superior genetic breeds

Systems of Breeding

Inbreeding – a system of mating where related individuals are mated together
- This system has been used by animal breeders in the production of seed stock in the development of the different breeds of swine.

Outbreeding – the mating of unrelated individuals to produce the next generation

Purebreeding - animals of the same breed are mated to each other resulting in the production of purebreds
- done to maintain the production supply of the breed

Example: L x L D x D LW x LW
Pi x P

Crossbreeding - mating of two animals from different breeds
- practiced to combine traits of different breeds
- the system recommended for the production of slaughter pigs

Examples: LW x LR P x Du

Upgrading
- improving an inferior breed by continued crossing, commonly used in native breeds
- native breeds are crossed with purebred swine

Production Systems

A. Sow Herd Enterprise

Farrow to feeder operation - starts with a pregnant gilt/sow to produce pigs weanlings, which are sold to other raisers who grows then until marketable weight is attained

Farrow to finish operation - starts with a pregnant gilt/sow to produce pigs weanlings, which are sold to other raisers who grow them until marketable weight is attained

Farrow to breeder operation - starts with a pregnant gilt/sow to produce the breeders stocks, specifically junior boars and replacement gilts

B. Growing-Finishing Enterprise
- starts with feeder/weanlings and carries them to slaughter, weight of about 80 to 90 kg

C. Boar-for-Hire-Enterprise

- starts with a young boar, which is grown and trained to breeder age
- The boar is used to breed the gilts/sows in the community for a fee

Swine Herd Management

Boar

- one of the most important animals in a pig enterprise
- A boar will generally produce 15 to 20 times as many offspring per year as do breeding females in the herd
- A period of at least 1 to 2 months before the breeding season begins is enough time for the boar to get adjusted to the new environment

Characteristics of a good boar

1. at least 6 pairs of rudimentary teats, not inverted
2. 2 big equally-sized testicles
3. strong legs
4. strong slightly arched back
5. toes not uneven

Characteristics of average ejaculate:

1. volume, ml: 150–200
2. sperm concentration, million/ml: 200-300
3. total sperm per week, billion: 120-150
4. motile sperm, %: 70
5. morphologically normal sperm, %: 60
6. color: creamy white

Feeding

- feed boars 2.3 to 3.0 kg of ration with 13 to 14% crude protein
- In the tropics, voluntary water consumption may be as high as 4 to 5 liters of water per kg of air-dry feed

Housing and Environment

- the pen measures 0.6 m x 2.1 m with a height of 1.1 m
- If the boar pen doubles as the service area, allow between 5 and 7m^2 of floor area
- use of individual pens or stalls eliminates fighting, riding, and competition for feed

Sexual Maturity

- a boar should start serving at 8 months of age
- Some boars reach sexual maturity as early as 100 to 147 days of age

Test Mating

- provides an opportunity to observe the new boar's sexual behavior and his ability to serve the gilt normally

Breeding Frequency

- Recommended service for boars

	Junior Boar (8 mos. - 1 year)	Senior Boar (more than 1 year)
Day	1	2
Week	5	7
Month	20	30

Boar to Sow Ratio

- Natural service - 1 boar for every 20 females
- AI + natural - 1 boar for every 20-30 females
- All AI - 1 boar for every 40-50 females

Management of Sows and Gilts

- the crossbred female is preferred for commercial production because it has the added advantage of hybrid vigor
- a steady supply of replacement gilts is required to replace sows, which die or are culled because of poor performance.
- under good management, sows have tremendous capability to produce 2.3 liters per year or over 20 pigs annually

Management of Developing Gilts

Characteristics of Good Replacement Gilts

- select from dams with good prolificacy and mothering ability, sound feet & legs, good growth rate & back fat and 14 or more well-spaced teats (none inverted)

Housing

- raise potentials gilt replacement in all-female group in dry, well ventilated pens that provide 0.56 to 0.74 m^2 of floor space per animal

Flushing

- increasing the daily feed intake of gilts by 0.5 kg to 1.0 kg for 10 to 14 days before service should increase the number of eggs ovulated if they were limit-fed at 2 kg per day before flushing

Recommendations at First Breeding

1. breed gilt at 8 months and at 110-120 kg
2. gilts should have their first litter at one year of age
3. a gilt should be bred on the second heat cycle, when the animal is on standing heat

Heat Detection

- proper and accurate heat detection is important for a successful mating system

Physical Signs:

1. swollen vulva
2. clear viscous vaginal discharges
3. restless and grunting
4. mounting behavior
5. frequent attempts to urinate with little or no discharges

Haunch–Pressure Test – the sow is approached from behind and her sides and thigh are rubbed

Riding-the back-test – applied by riding or merely pressing the back of the animal

Semen-on-the-snout test – particularly important in AI although it can be applied in natural breeding

Teaser boar – allowing a boar, preferably one that has been vasectomized, to mount the sow

Sound Test – use of chomping sounds of the boar

Mating System

Artificial Insemination - involves the collection of semen from a boar and then the introduction of semen into a sow or gilt at a later stage by means of a catheter

- Advantages:
  1. less number of boars needed

2. when obtaining semen from outside sources, there is a decreased risk of introducing diseases
3. allows the "mating" of animals of different sizes
4. labor cost to supervise matings is significantly less with AI than with natural service

Hand Mating - the boar and one sow (or gilt) at a time are brought together for servicing
- allows the producer to choose who gets mated and eliminate social competition
- accurate breeding dates can be recorded
- accurately check for return to heat
- boar use is regulated
- more labor and closer observation are required

Pen Mating – females are brought into the boar's pen and he services them all while they are in the pen
- least labor intensive
- inaccurate record of breeding dates
- boar service rates and female return to heat dates are often unknown

Management during Gestation
- the average gestation length of swine is **114 days** with a range of 109 to 119 days; simply put, 3 months, 3 weeks & 3 days

Housing and Environment
- in a penning situation, allow about 1.85 m^2 per bred sow or gilt
- stall measurement of about 0.5x 2.13 m is recommended

Feeding
- 1.8 to 2.3 kg of balanced 14% CP ration will meet the daily nutrient requirements

Management During Late Pregnancy
- growth of the developing embryos increases rapidly in the final third of pregnancy
- transfer of nutrients from the dam to the fetus increases gradually and retention in the uterus and mammary glands develops accordingly
- The greater demand for feed in the last trimester of pregnancy can be satisfied by increasing the level of feeding to at least 15% level of 2.0 kg

Management during Farrowing

Basic Farrowing System
- Continuous farrowing – sows to farrow are seen through a facility in a continuous flow with no breaks for total room sanitation
- All-in, All-out Batch Farrowing System – groups of sows due to farrow during the week are brought into individual rooms over a short time period

Pre-farrowing Operation
- Preparing the farrowing quarters – thoroughly clean the whole farrowing room or area
- Wash sow – before placing the sow in the farrowing unit, thoroughly wash her with a mild soap solution and rinse with warm water
- Transferring sows – to acquaint sows with their new surroundings, place them

in the farrowing unit 5 to 7 days before expected date of farrowing
- Parasite control – deworm sows 10 to 14 days before transferring them to the farrowing stalls
- Feeding the sow prior to farrowing – constipation of the sow at farrowing is a condition which needs to be kept

Signs of Farrowing
- she is restless, nervous and often bites the wall or stall partition
- there is distinct swelling of the mammary apparatus
- there us slackening of the abdominal wall
- Milk let-down: The presence of milk when the teats are stripped indicates that the sow will farrow within 24 hours

Supervised Farrowing
- an attendant should be present to assist the newly born pigs and the sow if necessary
  1. reduce stillborn pigs
  2. minimize crushing
  3. prevent starvation
  4. prevent predators
  5. avoid cannibalism
  6. minimize dystocia (difficulty in giving birth)

Causes of Difficulty in Birth
- a large litter and inertia of the womb.
- very large piglets and a small pelvis.
- two or more pigs presented in the birth canal at the same time
- rotation of the womb
- failure of the cervix to relax and open
- dead pigs inside the womb
- mummified pigs
- failure of the womb to contract (uterine inertia)
- nervousness of the sow, excitement and distress
- an over-fat sow

Management after Farrowing

Average Daily Gain

$$ADG = \frac{\text{final weight} - \text{initial weight}}{\text{Number of feeding days}}$$

Feed Conversion Ratio

$$FE = \frac{\text{amount of feed consumed}}{\text{gain in weight}}$$

Health Care
- inspect the sow's mammary apparatus for congestion, inflammation, laceration and other injuries. If these are present, watch out for MMA Syndrome
- Metritis (inflammation or infection of the uterus)
- Mastitis (inflammation of the udder)
- Agalactia (inadequate supply of milk)

Feeding During Lactation
- it takes about 7 days from farrowing for milk production and feed requirements of the piglets to justify liberal feeding of the sow
- to avoid overfeeding or underfeeding, the feeding level for lactating sows should be based on the number of pigs in the litter rather than on a per sow basis
- a sow with 12 suckling pigs should receive 2.0 kg feed for maintenance plus 1.0 kg for every three piglets in the litter or a total of 6.0 kg per day

Management of Piglets

Brooding

- the capacity of the pig to regulate body temperature starts to improve gradually only on the 7th day onwards up to the 20th day
- artificial heat source in the farrowing unit helps prevent losses from crushing because it attracts the piglets
  - 30-31°C for the first week at birth
  - 29°C to 30°C after the first week until the 6th week
  - 26 to 30°C for 50 kg pigs
  - 17 to 22°C for a 100 kg pig

Cutting of Umbilical Cord

- the umbilical cord is very vital for the growth and development of the fetus during pregnancy but becomes an unnecessary appendage and crucial area for the entrance of infection after the pig is born

Cutting the Needle Teeth

- Pigs are born with 4 pairs of sharp teeth (two on each jaws) called "black" teeth because of their darker color compared with the incisors. Some authors refer to them as "needle" or "wolf" teeth; they should be cut immediately after birth because they do more harm than good to the producer

Tail Docking

- done to reduce tail biting and cannibalism among pigs
- **Tail biting** is a major problem in many commercial swine farms in the country
- can be triggered by an injury to the tail and it requires only one pig in a group to start biting and the others quickly follow suit
- could also be due to excess humidity, trapped stale air and sudden changes in weather, shortage of protein and excess energy in the diet

Feeding with Colostrum

- **Colostrum** is rich in protective molecules and it is imperative that each newborn piglet consumes colostrum within hours of birth in order to receive adequate immunity against infective organism

Identifying the Piglets

Ear notching

- one of the most common methods used in identifying individual pigs in the litter
- a notch on the ear is permanent but difficult to read when obliterated through injuries
- done by cutting V shaped notch or notchers on specific areas along the borders of the ear by means of an ear notcher or scissors

Tattooing

- piercing outlines of desired numbers or figures on the skin inside ear and incorporating a black vegetable pigment into the punctures
- not popular as ear notching, although it is good as far as permanency of the mark is concerned
- often performed on older pigs, using a tattoo-ear marking outfit to which the desired set of numbers is fitted

Ear Tagging
- tags are made of light metal or strong plastic with the number stamped on them. Tags are fixed generally to the ear with special tagging forceps

Anemia Prevention
- baby pig anemia is an old and well known disease problem to the progressive producers
- this disease is due to deficiency in iron due to inefficient placental and mammary transfer of iron to the piglets
- the piglet is born with limited supplies of iron and if it had been born in the wild would depend on supplementation to its diet from iron bearing soils

Creep Feeding
- creep feed is given when the nursing pigs are about one week of age to make sure that they will be consuming sufficient amounts of the dry feed before milk production starts to decline
- helps in preparing the piglet for the diet on which it would have to live on after weaning

Rearing Orphan Pigs
- brought about by a number of factors like death of the sow after farrowing, udder disturbances, lactation failure and too many pigs in a litter
- there are various possibilities of rearing orphan pigs like fostering, artificial feeding and rotational feeding

Castration
- done when the pigs are about two weeks from birth or earlier
- uncastrated male pigs are known for aggression
- prevents "boar taint". Boar taint does not affect food safety, but it does change how meat tastes and smells

Weaning

Traditional weaning (TW)
- in traditional weaning, the pigs are weaned at 8 to 10 weeks of age
- with a gestation period of 114 days and a dry period of 26 days on average, a sow under the system will have only 1.7 to 1.9 farrowings per year

Conventional Weaning (CW)
- in conventional weaning, the pigs are usually weaned at 5 or 6 to 7 weeks of age

Early weaning (EW)
- entails weaning at 3 to 4 weeks of age

Very early weaning (VEW)
- artificial rearing (1 to 2 days weaning) and weaning from a few days (3 to 7 days) from birth to 2 weeks

Management of Growing-Finishing Pigs

Growing-finishing stage - the period from weaning to a slaughter weight of about 80 to 100 kg

Scour Control (Diarrhea)
- the most common cause of mortality and weight setbacks in weaning pigs
- the infectious agents causing the disease complex usually multiply in unsanitary facilities although they may also appear in relatively clean farms

Gastro-Intestinal Parasite Control

- deworming of growing-finishing pigs 1 or 2 weeks after weaning is generally recommended as part of a health program
- a second treatment ½-1 to 2 months after the first is necessary because it takes approximately about a month for the large roundworm to complete its entire life cycle so that the larvae not killed by the first treatment is vulnerable as adults

External Parasite Control

- the major parasites causing the problem are the mango mites such as the *Scnoptes scabiel* and the *Demodex phyllodes*
- ***Scnoptes scabiel***, the most common mite, burrows in the upper two-thirds of the dermis
- ***Demodex phylloides*** infestation seldom occurs in swine. The mites live in the hair follicles and cause a pimple-like lesion.

Vaccination

- hog cholera is nearly 100% fatal to pigs of all ages, and its virulence resistance to antibiotics and other drugs for treatment; its highly contagious nature makes it difficult to control

Feeding

- when the shift in the feed is done abruptly, the pigs especially the young ones develop diarrhea; shifting gradually from one diet to another prevents it

Feeding Systems

***Ad libitum* feeding -** giving feeds without restriction and always available at any time.

Restricted feeding - controlled amount of feed given to animals

Combination of ad libitum and restricted feeding – **f**ed *ad libitum* until they reach the weight of 50 kg and restricted-fed until they are marketed

Weaning to Conception Interval - intervening period from the end of the suckling period to the start of the next pregnancy

Non-Productive Days/Empty Days - the days that a female or gilt is not productive while part of an inventoried herd; traditionally, these are days in which the female is neither lactating nor gestating. NPD includes several commonly measured production parameters such as farrowing rate and weaning to re-service interval

Farrowing Interval - the period from the birth of one litter to the birth of the succeeding litter

- also known as Litter Interval
- Components :
  - ▶ Pregnancy Period
  - ▶ Lactation Period
  - ▶ Weaning to Conception

Farrowing Index - the average frequency of farrowing of a sow on a yearly basis

$$\frac{365 \text{ days}}{\text{Farrowing Interval}}$$

Common Name	Scientific Name	Egg Weight (g)	Incubatio p
1. Chicken	Gallus gallus		
2. Ducks •Mallard (egg) •Muscovy (meat)	Anas platyrhyn Cairina		
3. Turkey			
4. Quail			
5. Pi			

Farrowing Rate - the percentage of female farrowed compared to the number of females served
- Animals that farrowed /Animals bred

II. POULTRY PRODUCTION

Poultry

- popular because they are fast multipliers
- quick growers, more efficient feed converters
- chicken- the most popular poultry species
- duck – 2nd most popular (for balut, salted and century eggs)
- quail – 3rd most popular (for its eggs)

Zoological Scheme

KINGDOM:	Animalia
PHYLUM:	Chordata
CLASS:	Aves
ORDER:	Galliformes
	Anseriformes
	Struthioformes
	Columbiformes

Orders

- **Galliformes** – do not have true phallus (copulatory organ), with v-shaped breast
  ▶ chickens, turkeys, quails, game birds
- **Anseriformes** – have true phallus, with v-shaped breast
  ▶ duck, goose, swan
- **Struthioniformes** – have flat breast
  ▶ ostrich
- **Columbiformes** – secrete "milk"

Species of Poultry

Chicken

- Chick = young chicken
- Pullet = immature female chicken
- Cockerel = immature male chicken
- Hen = adult female chicken
- Cock/Rooster = adult male chicken
- Capon = castrated male chicken

Ducks

- Duck/Hen = adult female duck
- Drake = adult male duck
- Duckling = young (baby) duck

Turkey

- Tom = adult male turkey (also often referred to as a 'gobbler')
- Hen = adult female turkey
- Poult = young (baby) turkey
- Jake = young male turkey
- Jenny = young female turkey

Caruncle = brightly colored growths on the throat region; turns bright red when a tom is upset or during courtship activities

Snood = flap of skin that hangs over the turkey's beak. Engorges and turns bright red when a tom is upset or during courtship activities.

Common Name	Scientific Name	Egg Weight (g)	Incubatio pe
6.Geese	Cygnopsis cygnoides	20	
7. Swan	Olor columbianus		
8. Ostrich			
9. Peafowl			
10. Pheas			
11.			

Wattle = flap of skin under the turkey's chin. Turns bright red when the turkey is upset or during courtship.

Quail

- Hen = adult female quail
- Cock = adult male quail
- Chick/Cheeper = young quail

Pigeon

- Hen = adult female pigeon
- Cock = adult male pigeon
- Squab = young (baby) pigeon still in the nest; may also refer to the meat sold since pigeons are usually marketed before they leave the nest
- Squeaker = young pigeon in the year of its hatch
- Pigeon milk - the cottage cheese-looking crop substance produced by both cock and hen to feed the young from hatch until about 10 days of age

Goose

- Goose = adult female goose
- Gander = adult male goose
- Gosling - young (baby) goose

Swan

- Pen = adult female swan
- Cob = adult male swan
- Cygnet = young swan

Ostrich

- Hen = adult female ostrich
- Cock = adult male ostrich
- Chick = young (baby) ostrich

Peafowl

- Peahen = adult female peafowl
- Peacock = adult male peafowl
- Peachick = young (baby) peafowl

Pheasant

- Hen = adult female pheasant
- Cock = adult male pheasant
- Pullet = young female pheasant under one year of age
- Cockerel = young male pheasant under one year of age
- Chick/Poult = young (baby) pheasant

Guinea Fowl

- Guinea hen = adult female guinea fowl
- Guinea pullet = female guinea fowl under one year of age
- Guinea cock = adult male guinea fowl
- Guinea cockerel = male guinea fowl under one year of age
- Keet = young (baby) guinea fowl

The Chicken

Jungle fowl species known to modern ornithology

- **Red jungle fowl** (*G. gallus* Linnaeus, 1758)
- **Grey jungle fowl** (*G. sonnerati*, Temminck, 1831)
- **Ceylon jungle fowl** (*G. lafayetti*, Leeson, 1831)
- **Green jungle fowl** (*G. varius*, Shaw and Nodder, 1798)

Red jungle fowl – widely believed to be the most probable ancestor of the modern chicken

- exact ancestry of present-day chicken is unknown
- the present breeds and varieties are believed to have descended from the **Red Jungle Fowl** (*Gallus gallus*) of Southeast Asia
- 3 other species that contributed
  - **Gray Jungle Fowl** (*Gallus sonnerati*)
  - **Ceylonese Jungle Fowl** (*Gallus lafayetti*)
  - **Javan Jungle Fowl** (*Gallus varius*)

Development of Modern Breeds

- hen of the wild jungle fowl is 0.9 kg in weight and lays only a few eggs
- modern hen weighs 1.5 to 2.0 kg at 6 weeks of age and lays as many 320 eggs a year

What brought the change?

1. Genetic mutation

- some changes in the genetic make-up of certain individuals due to factors that are within as well as factors that surround the subject
- the change have been transmitted from generation to generation with the possibility of being modified from time to time as more factors and more individuals interact with each other

2. Selection

Natural Selection (survival of the fittest)

- climatic differences
- differences in nutrition

Artificial Selection – the interference of man in achieving certain goals and personal ideas in improving the chicken for meat, for eggs, for fightingcocks, for fancy feathers

3. Crossbreeding

Classification of Breeds and Varieties

Breed – a group of chickens (fowls) possessing certain conformation or shape of body that distinguishes them from other chickens

Variety – a group of chickens within a breed that have the same plumage color and type of comb

Strain – a group of chickens within a variety of a breed which has undergone constant specific selection for certain traits by a specified breeder for periods of about 5 to 8 years

Classification Based on Utility

1. Egg Class

- breeds belonging to this class are characterized by their comparatively small size
- lay large white-shelled eggs; very active and nervous in disposition
- non-sitters

  Examples: **Leghorn, Minorca, Ancona, Mikawa**

2. Meat Class

- large breed, slow in movement, quiet and gentle in disposition
- generally poorer egg layers and lay brown-shelled eggs

Examples:
Brahma
Cochin
Langshan
Cornish
White Rock

3. **General Purpose Class**
   - breeds in this class are medium sized, good layers; the young are fast growers
   - not as nervous as the egg class but much more active than the meat class

   Examples:
   New Hampshire
   Rhode Island Red
   Plymouth Rock
   Lancaster
   Nagoya
   Cantonese

4. **Fancy Class**
   - with beautiful plumage or form or having a rare unusual appearance
   - most are raised chiefly as ornamentals or pets by hobbyists, regardless of their value as a source of food

   Examples:
   Frizzle
   Bantam
   Long Tailed

5. **Fighting Class**
   - breeds/bloodlines of this class have been developed by national and international aficionados in this sport
   - the game fowl industry is a vibrant industry in the Philippines, providing good income to breeders and others working indirectly or indirectly for the industry

   Examples:

Hatch	Regular Grey
Sweater	Dom
Claret	Butcher
Lemon	Kelso
Whitehackle	Brown Red
Roundhead	Muff
Orientals	

Standard Classification
- in this classification, breeds and varieties are grouped according to their geographical origin

1. **American Class**
   - breeds and varieties developed in the American continent
   - the most popular are Plymouth Rock (White, Barred, Speckled, Brown), Wyandottes, Rhode Island Reds, New Hampshire, Lancaster

2. **Asiatic Class**
   - breeds developed in Asia
   - Brahmas, Cochin, Langshan, Cantonese, Nagoya

3. **Mediterranean Class**
   - related to its utility grouping since chickens of Mediterranean origin are egg type. They produce large white-shelled eggs
   - Leghorn, Minorca, Ancona

4. **English Class**
   - especially the breeds developed in England and in its colonial

territories like Dorkings, Australorp, Cornish, Orpington

5. **Other classes by origin**
–Polish, Hamburg, French and Oriental classes

Specialized Fields in Poultry Production

Modern trend in poultry production is towards specialization. Farmer chooses what production area he is interested in.

3 Categories of Major Areas in the Poultry Business

Breeding Farm

- the system of researching or discovering the best combination of genes of parent stocks that will be the source of commercial chicks for the poultry producer
- the existing "strains" or probably across of various lines now available to a commercial poultry raiser is a product of very long studies by the geneticist
- **there is no true commercial poultry breeding farm existing in the Philippines**
- poultry breeding farms in the country are multiplier farms, which are franchised breeder farms of international breeders
- essential segments are grandparent/parent stocks, hatchery, and distribution system

Egg Farm

- egg production is the older scheme of poultry production engaged in by many research

Two phases of operation
1. strictly for raising pullets
2. the keeping of layers *per se* when they are on lay

- female egg type chicks are obtained from reputable hatcheries

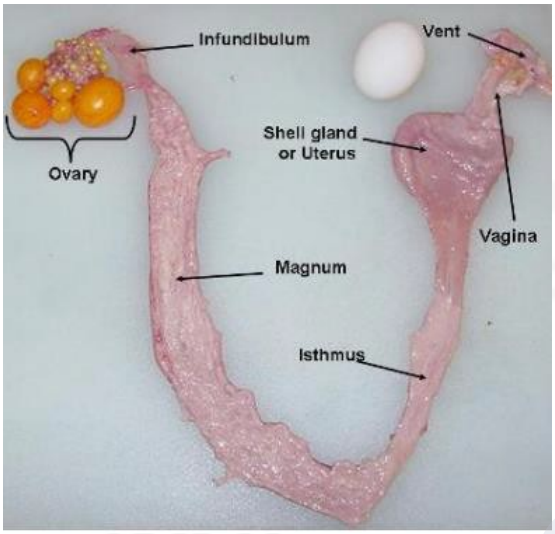
Broiler Farm

- the most recent specialized field in the Philippines
- the growing of meat-type chicken for meat production
- stocks used are broiler- type chicks which are known for their fast growth, meaty conformation and good feed conversion
- grown for a period of only about 4 to 6 weeks
- both male and female chicks are utilized; males grow faster than females

Avian Female Reproductive System

Ovary – produces the ovum
Infundibulum – receives yolk from ovary where sperm is stored, and fertilization takes place (15 minutes)
Magnum – secretes the thick white of the egg (3 hours)
Isthmus – shell membranes are placed around the yolk and thick white (1 ¼ hours)
hell gland – thin white and outer shell are added to the egg (20 hours)

agina – completed egg is stored for a short time until laid (total: 25-27 hours)



Source: Jacquie Jacob, University of Kentucky

The reproductive system of a hen in lay

Hatching Eggs

Natural

- the hen lays eggs (1 per day) over period of several days
- a group of eggs laid by a hen sequentially is called a **clutch**
- after 21 days of sitting (incubation), the eggs hatch
- a hen that sits on her eggs to hatch them is referred to as "broody"

Artificial

- incubating eggs in an artificial incubator
- incubator keeps eggs at proper temperature and humidity
  - ▶ **Temperature: 97-102 degrees**
  - ▶ **Humidity: 60%**
- eggs are turned 3-5 times daily (manual incubators) to prevent embryo from sticking to the shell membrane

Selection of Hatching Eggs

Grading Exterior Quality

1. Cleanliness – shell should be free of debris or organic matter
2. Shape – small end and large end – not round or oblong
3. Soundness – no cracks
4. Size – not very small or extremely large

Grading Interior Quality

1. Air cell
2. Viscosity of albumen (white)
1. eck for abnormalities (blood/meat spots, cracks or leaks in shell

Candling

- e to test for egg fertility and viabilility
- e by placing the egg against a bright light such that the outline of its contents are seen from the outside
- candler or tester is used
- e in 3 periods:
  1. 4^{th} or 5^{th} day – to remove infertile eggs
  2. 13^{th} day or 14^{th} day
  3. 18^{th} day – remove dead embryos
- dle eggs to determine their interior and exterior quality grade

Brooding Management

Brooding

- tarts as soon as the chicks are placed in the brooder area where heat is supplied until they have grown to the point where they no longer need additional heat to keep them comfortable
- asts for approximately 4 weeks

Types of Brooder

Battery-type brooder – composed of compartments called tiers constructed one on top of another, each compartment equipped with separate heater and provisions for feeding and drinking

Cage brooder - can be elevated slatted-floor or litter-floor type with capacity varying from few to several hundreds

Temperature Requirements

- Day old - 1 week 90 - 95 °F(32.2 - 35 °C)
- 1 - 2 weeks 85 - 90 °F (29.4 - 32.2 °C)
- 2 - 3 weeks 80 - 83 °F (26.7 - 29.4 °C)
- 3 - 4 weeks 80 °F (26.7 °C and below)

1. electricity
2. liquefied petroleum gas (LPG)
3. infrared lamp
4. kerosene lamp
5. charcoal

Floor Space Requirements

- <u>Egg type chickens</u>

1 day - 3 wks	0.3 sq.ft/bird
3 - 8 wks	0.5 sq.ft/bird
8 - 12 wks	1.0 sq.ft/bird

- <u>Meat type chickens</u>

1 day - 2 weeks	0.3ft^2/bird
2 wks – market age	1.0 ft^2/bird

after 12 weeks, the floor space requirement of growing pullets varies according the systems of housing used

- Litter floor 2.0 - 2.5 sq.ft/bird
- Slat floor 1.5 - 2.0 sq.ft/bird
- Cages 0.75 - 1.0 sq.ft/bird

House Features

- Construction materials
  - ▶ bamboo slats, nipa shingles, coco lumber
  - ▶ GI sheets, aluminum sheet, wood, welded wire, plastic nets
- Shape – long and narrow with east-west orientation
- Width – 10 to 12 meters
- Height
  - ▶ floor height – 1.8m or 5,9ft
  - ▶ floor-to-ceiling – 2.4m or 8ft
- Roof style
  - ▶ shed type
  - ▶ gable type
  - ▶ combination (shed-gable)
  - ▶ monitor type
  - ▶ semi-monitor

Light Requirement

- very important in the development of pullets
- the correct light-to-dark ratio in the rearing house will influence the production of larger eggs
- in the first few days of brooding, lighting the chicks throughout the night (24 hours light) is favorable for growth because there is eating time if food is available

- light in the brooder will encourage the birds to keep close to source of heat, feed and water

- one cardinal rule: **Never increase light during growing period and never decrease light during the laying period**

Pineal Gland

- part of the chicken's endocrine system
- located behind the eyes, above the midbrain
- produces melatonin that helps to regulate sleep and other body functions
- when the natural lighting period of day lengthens, the pineal gland of the hen responds by sending a hormone through her body to ovary to start producing eggs
- when the days shorten, the pineal gland stops sending this hormone
- light sensitive, so you can fool it by increasing the amount of light available to the hens
- increasing day length (light) during the growing period of birds will hasten their sexual maturity, which will result in production of more pullet eggs (small eggs); layers are prone to prolapse and shorter egg production cycle
- decreasing day length in the laying period will inhibit the secretion of reproductive hormones from the pituitary gland and should never be allowed to occur when egg production is desired

Vaccination, Medication and Beak Trimming

Cannibalism

- a bad habit developed by some growing birds. It usually starts from feather or toe picking which may result in serious wounding and death

- the possible causes of cannibalism are:
  1. Imbalanced ration - a high energy diet with low protein leads to this problem
  2. Overcrowding and insufficiency of feeding and drinking spaces
  3. Extended period without feed and water
  4. Poor ventilation
  5. Excessive heat and too much light
  6. May also be a strain characteristic

Beak trimming - the partial removal of the beak of poultry to prevent feather pecking and cannibalism

Factors affecting length of brooding period

a. Weather/Climatic conditions – longer during cold and rainy months, shorter during dry and warm months

b. Rate of feathering – shorter for fast feathering: can be due to genetic makeup or nutrition of the birds

Growing Management

Rearing System

Range System – this is a good system but because of more land area required, is commonly practiced by native chicken growers & duck raisers

Advantages:

1. savings on feed
2. no labor requirement for management
3. bone development relatively better
4. equipment are hardly used
5. less expensive
6. birds get the benefit of getting enough sunlight

Disadvantages:

1. easy disease outbreak
2. more space required

Semi – confinement system –a system of raising poultry where birds are provided with shed or housing & an area to graze or pasture.

Ex: native chicken, organic chicken production

Advantage: low in cost

Disadvantage: Losses may occur because of birds of prey and from failure to find eggs laid in bushy areas

- the poultry run requires a considerable amount of fencing

Complete confinement – the modern trend in raising commercial strains

- litter floor and/or slat floor
- cages

Advantages:

- birds are totally confined
- most efficient
- convenient and economical system for modern poultry production

Rearing of Pullets

Feeding requirements of growing pullets

- 6-14 weeks Grower ration 16% CP
- 14-20 weeks Pullet developer ration 14% CP

- birds tend to lay eggs early when feed has high protein content, which is not desirable since early sexual maturity results in smaller pullets & consequently production of smaller eggs

- feeding trough should not be filled to more than 1/3 of its capacity to prevent feed wastage. The feeder should be replenished 3-4 times a day to stimulate feed consumption.

Signs of sexual maturity

1. change in appearance of the secondary sexual characters
2. comb & wattles begin to increase in size & becomes red
3. pullets become friendly & cackle
4. pullets instinctively look for nest

5. pullets become docile (easily managed) & gregarious (sociable)
6. the vent & abdomen become enlarged

Note: The surest sign of sexual maturity is the laying of the 1st egg.

Layer Flock Management

- Thee major factors affecting nutrient requirements for egg production are:

1. rate of egg production
2. egg size or weight
3. egg shell thickness
4. body size of layer

- The principal factor affecting eggshell quality is dietary calcium

- Eggshell quality can be measured by specific gravity of egg, shell thickness, shell smoothness, breaking strength and percentage of cracks or shell appearance

- Low dietary calcium levels (less than 2.0%) decrease eggshell quality in chickens

Egg composition

- largely proteins and lipids and various minerals and vitamins with A, D, thiamine and riboflavin in bulk amount; poor source of carbohydrates

Systems of rearing of layer flocks

Range system – good system but needs more land area, commonly practiced by native chicken growers and duck raisers

Semi-confinement – a system where birds are provided with shed and an area to graze

Complete confinement – modern trend in raising chicken

Daily Routine of Work in the Layer House

Feeding

- layers must be fed a dietary composition referred to as layer ration or breeder ration
- layer ration will generally contain a 15-18% protein level
- day-old to 6 weeks old – chicks starter mash (20% CP)
- 6 to 12 weeks old – grower feeds; 16% CP
- 12 to 18 weeks old – developer feeds; 14%CP
- 18 to 42 weeks old – layer 1 feed; 18% CP
- 42 weeks to culling – layer 2 feeds; 17% CP

Watering

- drinking water must be available to the layers all the time
- the egg is about 65 to 70% water

Egg Collection

- capable of laying one a day but it is next to impossible to realize one-egg-one- day for long periods of time
- skip some days in egg production
- oviposition (the act of egg laying) takes place normally as early as 7:00 AM to as late as 4:00 PM
- majority of hens lay their eggs between 10:00 AM and 2:00 PM

- the concentration of egg laying takes place before noon

Flock Replacement

- vary from a set of one flock every 3 months
- can be as often as a monthly setup of replacement stocks depending on the program and availability of facilities

Classification of table eggs based on weight

Classification	Weight	
	grams	ounces
Jumbo	68.5	2.4
Extra large	61.4	2.2
Large	54.3	1.9
Medium	47.2	1.7
Small	40.2	1.4
Peewee		

Systems of Broiler Operation

All-in-all out system

- single-age-group raising of broilers
- most desirable to effect simple disease control measure especially if there are no other chickens in the area

Two stage operation

- two age groups of broiler are kept in the farm; calls for separate brooder house and grower house

Multiple Stage broiler operation

- this is similar to the two-stage broiler operation except that there should be more units to facilitate as many stages or accommodate various ages of broilers

- the turnover of chicks can be either daily, every 2 days, weekly bi-weekly, etc.

Contract Growing of Broilers

1. Integrator company (contractor)
2. Farmer (grower)

Classification of Broiler Raisers

1. Independent raiser
2. Contract grower

Broiler Strains Marketed in the Philippines

Strain	Local source
Arbor Acres	San Miguel Corporation
Cobb	Sarmineto Agricultural Development Corporation
Starbro	Universal Robina Farms
Indian River	Winmar Poultry Farms Inc.
Peterson	RFM Corporation
Pilch	General Milling Corporation

III. BEEF CATTLE PRODUCTION

Beef Cattle Breeds, Breeding and Reproduction

Origins of Modern Cattle

Aurochs (*Bos primigenius*)

- India thought to be the homeland of primitive cattle which later expanded to Eurasia and North Africa
- Some species related to the Aurochs also underwent domestication

Yak (***Poephagus grunniens***)

- from mountains of Tibet
- some regions of middle Asia
- South Siberia

Genus Bibos
- (*B banteng*) or Ban cattle
- (*B frontalis*) or gayal
- from India, Malay archipelago and Indochina, particularly Burma

Modern Cattle
- modern cattle family Bovine, genus Bos
- first domesticated during the stone age, within 10,000 B.C. from the wild ox or *Bos primigenuis*

Bos taurus
- of European origin such as Shorthorn or Jersey
- without humps and therefore of temperate origin

Bos indicus
- of tropical origin such as the Brahman or Zebu of India or Afrikander of Africa
- humped cattle
- adapted to tropical conditions (has survived through centuries of exposure to inadequate conditions such as food supplies, insect pests, parasites/diseases and extreme weather conditions)

Characteristics of Zebu Breeds as Compared to Temperate Breeds

- large hump over top of shoulder and neck
- large pendulous ears
- dewlap having large amounts of excess skin
- highly developed sweat glands (perspire more freely)
- oily secretion from the sebaceous glands

Breeds of Beef Cattle

Shorthorn
From : England
Color : Red, red and white, or roan
Size : Mature Bulls: 1,000–1,300 lbs, mature Cows: 800-1,200 lbs
Popularity Factors : dual purpose breed for milk and meat

Charolais
From: France
Color: White
Size: Mature Bulls: 2,800-3,300 lbs, Mature Cows: 1,400–2,500 lbs
Popularity Factors: long- bodied large cattle; heavily muscled

Brahman
From : India
Color: White to grey, red to black.
Size: Mature Bulls: 2,800-3,300 lbs, Mature Cows: 1,400-2,500 lbs
Popularity Factors: insect and heat resistant, able to survive on little, poor feed; have sweat glands

Texas Longhorn
From : North America
Color: Diverse coloring
Size: Mature Bulls: 2,800-3,300 lbs, Mature Cows: 1,400-2,500 lbs
Popularity Factors: can eat very poor vegetation; lean beef and really long horns

Hereford
From : Hereford, England
Color: Red or Black with white head, legs, and underline
Size: Mature Bulls: 2,000-2,500 lbs, Mature Cows: 1,00–1600 lbs

Popularity Factors: Excellent mothers. Very adaptable to any environment, juicy tender meat. Very easy to handle

Angus

From : Scotland
Color: Black hair and skin or red hair and skin
Size: Mature Bulls: 1,000-1,300 lbs, Mature Cows: 800-1,200 lbs
Popularity Factors: excellent mothers; naturally no horns and natural marbling for tasty, tender beef; very easy to handle

Simmental

From: Switzerland, came to the United States in 1971
Color: pale yellow-gold all the way to very dark red or black
Size: Mature Bulls: 2,200-2,800 lbs , Mature Cows: 1,100-1,500 lbs
Popularity Factors: Gentle and large with heavy milk production; very lean meat; very easy to handle

Breeding Systems

- several types of mating to combine desirable qualitative and quantitative characteristics through mating systems which are planned or non-random

Random mating – each possible mating in a population has the same probability or occurrence

Inbreeding – mating of closely related individuals within a breed

Effects of Inbreeding

1. marked decrease in fertility
2. reduces vigor
3. decrease in growth rate of offspring
4. reduces viability of the offspring

Close breeding – matings of close relatives ex., father – daughter, son – mother, brother, sister

Line breeding – breeding of not so close relatives, ex, cousins
- ▶ a form mild inbreeding designed to concentrate the genes of a certain incest or of the genetic constitution of the progeny

Strain breeding – a very mild form of inbreeding which leads to increased homozygosity within the strain in the long term

Crossbreeding

- mating of individuals from two or more established purebreds
  - ▶ increases heterozygosity
  - ▶ takes advantage of hybrid vigor or heterosis

Types of Crossbreeding

Systematic crossbreeding – two or more breeds are involved in a breeding program lasting several years. This way, a crossbred which may eventually stabilized into a breed, e.g., Brangus (Brahman x Angus), Charbray (Charolais x Brahman)

Upgrading - the mating of purebred sires to nondescript or native female and her offspring generation after generation

Reproduction

Reproduction Phenomenon

- **Sexual Maturity (bulls/heifer)**: 6-8 months
- **Estrus Cycle:** 18-24 days (Ave: 21 days)
- **Estrus duration:** Exotic/ European breeds- 14-18 hrs.; Indigenous/Zebu- 10-12 hrs.
- **Ovulation:** 10-14 hrs after end of estrus
- **Pregnancy:** Average of 283 days
- **Bull Ejaculate:** 2- 12ml of 500 or more sperm cells/ml
- Sperm cells survive the oviduct up to a maximum of 48 hrs.

Breeding Methods

Natural Method- conventional use of bull to impregnate a heifer or cow

Handmating – a bull in good condition can serve 3-4 times/week or one service every other day:

- 18 months old – 1:12-15
- 2 yrs old – 1:20-25
- 3 yrs old – 1:40-50

Artificial insemination - process of fertilization in the female without the benefit of sexual contact between male and female animals

Indicators of Good Breeding

Conception rate (Pregnancy)

- percent of breeding females that conceived versus the total exposed females

CR = (Cows pregnant at the end of the breeding season / Cows exposed during breeding season) x 100 % (**90 or 120 day) non returns**

- percent of breeding females confirmed pregnant at 90 or 120 days, by pregnancy diagnosis, versus the total exposed females. This is similar to conception rate.

Calving Rate

- percent of breeding females that give birth versus the total exposed females

Calving Interval

- the average length of time (in days) between successive calving
- can be calculated for each cow or the entire herd
- one year is ideal; eighteen (18) months is common

First heat after parturition

- –the occurrence of estrus after giving birth to a young; first heat is related to calving interval

Feeding Beef Cattle

Common Feeds for Ruminants

Forages

- the natural cheapest feed for ruminants and includes not only grasses but also legumes

By-product roughages

- most are highly fibrous (rice, straw, corn cobs, sugar cane tops), low in CP and TDN and have poor digestibility

Concentrate

- unlike in developed countries, little amount of grain is fed ruminants locally. Copra meal, rice bran, wheat pollard are commonly used by-product concentrates, contain from 20% as in case of molasses to 21% in copra meal.

Use of Urea

- urea has long been used as partial protein source for ruminants in other countries
- The following guidelines are recommended for the safe use of urea:
- Add fertilizer grade urea at not more than:
    1. 1% of the ration (DM basis)
    2. 2.3% of the concentrate mixture, (air-dry basis) or
    3. 25.30% of the total dietary protein

Herd Management

- to produce a crop of high quality, heavyweight calves

Herd division

- ensures the appropriate nutrition of various age groups of the herd

- prevents premature breeding which seriously affects the growth of young bulls and heifers and prevent high rate of abortion resulting from butting and fighting of animals

Pregnant herd – composed of pregnant females. Cows are grouped with the breeding herd during the breeding season.

Breeding herd – consists of dry cows and heifers ready for breeding. After the breeding season, pregnant animals are transferred to the pregnant herd.

Heifer herd – composed of heifers not yet ready for breeding. Heifer calves are included in this herd after weaning.

Steers, feeders or fattening herd – consists of growing cattle and those to be fattened for the market

Bull herd – consists of mature males kept mainly for servicing the breeder cows

Management of Breeding Females

Lactating and pregnant cows

- pregnant cows are separated from the herd to prevent injury and possible abortion due to riding, butting and fighting with other animals

Signs of pregnancy:

- cessation of estrus or heat
- enlargement of the abdomen and udder
- palpation 60-90 days after breeding (more reliable pregnancy test)

Pregnancy diagnosis

- an important tool to measure the success of reproductive management of a cattle herd

- rectal palpation is probably the most commonly used method of pregnancy diagnosis

Rectal Palpation

- the manual examination of the reproductive tract by way of the rectum and colon to verify pregnancy in cattle

- determining pregnancy in cattle is not particularly difficult, but requires experience, practice, and a thorough knowledge of the cow's reproductive system

- To accurately determine pregnancy, the palpator inserts his/her hand into the cow's rectum, locates the reproductive tract through the rectal wall, and determines whether pregnancy exists by examining the condition of the tract

Other Methods of Pregnancy Diagnosis

Ultrasound

- detection of pregnancy through the use of ultrasound may be beneficial during the later stages of pregnancy (day 30 or later)
- organs of the reproductive tract and the developing fetus can be viewed using ultrasound technology
- a probe is passed over the cow's abdominal wall or into the rectum to transmit two-dimensional images to a
- monitor that can be viewed by a technician

Biochemical Tests

- on-farm test kits are available to producers to pregnancy-check their cows
- some kits are easy to use and give the producer immediate results
- one example of a test kit is a milk progesterone test, which allows a producer to test the level of progesterone in a milk sample
- color change in the sample indicates the pregnant or non-pregnant status of a cow

Management of Open Cows and Heifers

- should be given the right amount of feed daily to ensure that they are in the right physiological status

Management of Calves, Growers and Fatteners

Calves - should suckle colostrum milk from their mother within three hours after calving

Growers - usually maintained at the pasture with very little attention. They are given salt and mineral supplement.

Fatteners - require a shorter period to reach slaughter weight. They are generally bigger, mature, or nearing maturity. However, one-and-a-half to two year-old animals weighing 200-300 kg are preferred. They may be fattened either in feedlot, on pasture, or both areas.

Housing

Enterprise	Class of animal	Feeding space linear mm/hd.
1. Feedlot 2. Ranch 3. Dairy cattle		750
	Calves (3 – 6 mos.)	450
	Calves (7 – 12 mos.)	500
	Yearling, heifer, milking & dry cows; Cows in maternity stalls	750

Minimum Feeding Space Requirement

Enterprise		Floor space, m^2/hd
1. Feedlot	Shed area	4
	Loafing area	5
2. Holding Pen	Up to 270 kg	1.3
	270 – 540 kg	1.6
	Over 540 kg	1.9
3.Dairy Cattle	Calves (up to 3 mos.)	1
	Calves 3 – 6 mos.	2
	Calves 7 – 12 mos.	3
	Yearlings	4
	Heifer/Steer	5
	Milking & dry cows	6
	Cows in maternity stalls	10

Minimum Floor Space Requirement

General Management Practices

Cattle identification

- necessary for management purposes and to denote ownership

Branding with hot iron is the most common method of identifying cattle. The owner's brand is placed on the animal's left foreleg.

Putting ear tags or ear notches are other effective methods of identifying cattle.

Dehorning - the process of removing or preventing the growth of horns

Benefits

1. Improves appearance
2. Reduces injuries
3. Increases feeder space
4. Improves value

Two methods:

1. Non-Invasive
2. Invasive

Types

1. Barnes' dehorner
2. Scoop dehorner

Castration - the process of removing the testicles from a male

Benefits

1. Prevents mating or fighting
2. Improves carcass quality

Two methods

Non-invasive

- Bloodless
- Crimps or constricts arteries – testicles die
- Young calves or weanlings

Types:

1. Burdizzo
2. Elastrator
3. Calicrate bander
4. Short-scrotumed
5. Chemical castration

Invasive

- Blood flow
- Sanitation is key
- Do not reach into the wound because it could cause infection

Types

1. Knife/scalpel
2. Emasculator

Selection and Culling

- Breeding stock with poor performance should be culled for slaughter. These are as follows:
  - ▶ a cow that calves every one and a half to two years
  - ▶ a cow that produces a little amount of milk and raises a small calf despite good feeding and management
  - ▶ small, weak, and unhealthy animals which are susceptible to diseases and may become the source of infection of the herd if not removed on time

IV. DAIRY CATTLE PRODUCTION

- Relatively good dairy cows in the Philippines and in most of the tropics correspondingly yield only about 8-12 kg daily
- A common "rule of thumb" is to feed one kg of reasonably good concentrate mixture for every 2.5 kg of milk in excess of 5 kg if the forage is of good quality

Milk composition

- Mainly of water, fat, protein, lactose (milk sugar) and ash
- Varies depending upon the animal species, breed, individuality, season, lactation, level of nutrition and management
- A rich source of calcium, riboflavin (B_2), Vitamin B_{12}, iodine and phosphorus
- Contains all the essential amino acids
- Its protein is composed of globulins, casein and lactalbumin
- Portions of the globulins of milk are structural parts of antibodies. Casein is the most abundant protein constituent of milk.

Colostrum – the first secretion of the mammary gland, higher than milk in dry matter, protein, vitamins and minerals; also contains antibodies that give newborn animals protection against diseases
  - milk produced under ideal condition has slightly sweet and pleasant taste
  - milk with low fat content tends to be flat while that with higher fat has creamy and fuller flavor
  - milk fat has the most variable milk constituent

Lactose - a sugar milk and can be digested by the enzyme lactase produced by humans

Lactose intolerance – occurs when man does not produce enough lactase to completely digest the lactose. This undigested lactose stays in the intestinal tract, and with the action of microorganisms causes abdominal pain, diarrhea and flatulence (gas).

Pasteurization – the process of heating milk to a certain temperature for a certain period of time required to destroy any pathogenic microorganisms

Types of Market Milk

Fresh milk – liquid whole milk solid either pasteurized, pasteurized/homogenized or sterilized/homogenized. Whole milk is milk from milkfat that has not been extracted.

Pasteurizaed milk – milk heated to a temperature of not lower than 145ºF (62.8ºC) for a period of less than 30 minutes.

Homogenized milk – milk that contains finer globules of butterfat than those present in fresh milk. It is prepared by passing fresh milk though small openings by pressure in a vacuum.

Evaporated milk – fresh milk that has been evaporated to a concentration of

60% of water. It contains 7.9% milkfat and 18% solid-not-fat.

Condensed milk – concentrated milk to which sugar has been added to preserve it. It contains 42-43% sugar, 8% fat/30% milk solids and 28% moisture

Dried milk – whole milk powder obtained by evaporating the moisture from the milk solids

Toned milk – a liquid milk product whose fat content is standardized to 3% by adding skim milk or reconstituted non- fat dry milk to high-fat fresh milk

Flavored milk – consists of milk, flavoring material and sugar

Skim milk – fresh milk whose cream has been removed. When dried to contain 97% solid, the product is called skim milk powder or non-fat dry milk.

Cream – re-concentrated fat globules of fresh milk containing 16% to 60% fat and obtained by gravity method or by configural cream separator,

Milk Products

Whole milk

- Upon drying: whole milk powder
- Upon separation: cream and skim milk

Cream

- Upon churning: butter and buttermilk

Buttermilk

- Upon drying: buttermilk powder

Ice cream – frozen dairy product made from a combination of cream, sugar, non-fat, dry milk, stabilizer and flavoring

Milk ice and milk lollies – similar to ice cream but have significantly lower milkfat (about 2% or less) and total solids (20% or more) compared to ice cream. The water content is higher.

Yoghurt – has an acid flavor and a smooth and light custard texture. The lactic ferementation of yoghurt is accompanied by *using Streptococcus thermophilus* and *Lactobacillus bulgaricus* growing symbiotically

Skimmilk

- Upon drying: skimmilk powder or non-fat dry milk
- Upon acidification or addition of rennet: cheese (add casein) and whey

Whey

- Upon drying: whey powder

Evaporated milk – whole milk from which about 60% of the water has been removed and contains not less than 25.8% total milk solids and 7.8% milk fat. Also known as sweetened condensed milk; compared to raw milk, it has greater viscosity and is creamy in color.

Homogenized milk – milk which has been treated in such a manner as to ensure break-up of the fat granules

Milk and Milk products

Milk
- nature's most perfect food
- with its assortment of protein, fat, lactose (milk sugar), minerals, vitamins, enzymes, and water

Nutritional Importance of Milk

- contains all the essential amino acids needed by humans
- the protein of milk is composed of casein, lactalbumin, globulin, and serum albumin
- other constituents of milk include lactose, minerals such as Ca and P (both of which are important in bone growth and other body functions), and vitamins
- low in Fe, therefore young animals consuming nothing but milk may develop anemia
- contains several important vitamins such as a vitamin A, which help keep the intestinal tract and skin in proper repair, the Vitamin B complex, and vitamins D and E. Vitamin D is added to most marketed milk.
- low in Vitamin C, which prevents scurvy (a disease characterized by bleeding, spongy gums and loose teeth)

Breeds of Dairy Cattle

Holstein
- dominates the industry
- +90% of the dairy cattle in the US
- officially known as Holstein-Friesian
- from Netherlands and Northern Germany
- typically black and white in color
- total milk solids % are lower (Solids refer to milk fat solids found in milk. These are used to determine quality and use of the milk produced by that breed of cattle)

Jersey
- 2nd to Holsteins in popularity
- developed on the island of Jersey, off the coast of France
- coat color ranges from light tan to almost black
- ability to efficiently convert feed to milk
- lower body maintenance needs
- amount of milk produced per cow is lower
- total solids %- highest of all breeds

Brown Swiss
- 3rd most popular
- originated in Switzerland
- normally brown to gray
- similar to Holsteins in size
- known for its ability to produce milk in hot climates

- 2nd in milk production
- Total solids % in middle of all breeds

Milk production as a trait
- milk production is a secondary sex characteristic
- genetic improvement is dependent on adequate supply of high-genetic potential heifers to replace culled cows
- profitable milk production and genetic improvement of dairy cattle are dependent on high degree of reproductive efficiency
- dairymen agree that a 12-month calving interval is ideal to maximize production and profit

- Failure to maintain this high degree of reproductive efficiency is a major economic loss
  - ▶ decreased milk production
  - ▶ decreased feed efficiency
  - ▶ decreased number of calves
  - ▶ increased costs

A normal cow becomes pregnant on the first or second service and produces a live and healthy calf every 12-13 months

Sterility

- Complete absence of reproductive ability
- Animals cannot reproduce
- Should be culled from the herd

Infertility

- Lowered fertility
- Animals that are not sterile, but not normally fertile

Sterility and Fertility

- not a single problem but a very complex one
- may be a result of one or more factors
  - ▶ management
  - ▶ genetic
  - ▶ physiological
  - ▶ disease

Reproductive Physiology

- successful reproduction involves a series of physiological functions by both male and female
- The male functions are
  - ▶ produce large number of sperms
  - ▶ ejaculate th5e sperm into the vagina of the cow
- the function of the female in successful reproduction is more complex than the male because her role continues after fertilization
- The female functions are
  1. To produce viable ova
  2. To deliver the ova to the site of fertilization
  3. To provide optimum environment for fertilization, embryo development, implantation and development of the fetus to term
  4. To deliver a live, healthy calf at the end of gestation

Reproductive Physiology of the Bull Spermatozoa

- produced in the seminiferous tubules of the testis
- stored in the epididymis
- volume of semen per ejaculate varies from 2-15ml (5-6 ml average)
- sperm concentration ranges from 1-3 B sperms per ml (2 B/ml average)
- percent motile cells ranges from 0-85% (75% average)
- in natural service, a bull may service 50 to 100 cows per year
- in artificial insemination, a bull can service 10,000 to 20,000 cows per year

Artificial Insemination

- semen is normally collected with the use of an artificial vagina
- ejaculate is evaluated for concentration, motility, and morphology
- semen of inferior quality is discarded
- semen is diluted with an egg yolk-citrate or milk-based extender (if to be frozen, with glycerol)
- dilution rates are calculated to yield final motile spermatozoa per insemination of 10-12 million.

- semen is packaged in ampules or straws, frozen and stored
- semen is usually frozen in liquid nitrogen at -184 to -196 C
- can remain viable for 10–15 years

Reproductive Physiology of the Cow

Ovum

- 4-6 days after fertilization, will move in the uterine horn
- 30-33 days after fertilization, will be implanted in the uterus to develop into a full term calf
- calf is discharged through the cervix, vagina and vulva
- ovum production and release begins at puberty (6-10 months of age) and continues on a 21-day cyclic basis until pregnancy
- normally re-established within 40-50 days after calving and continues until pregnancy occurs again

Reproduction

- successful reproduction involves the presence of viable male and female cells in the right place at the right time
- in combination with a normal, healthy female to provide suitable environment for the growth, development, and delivery of the calf

Breeding

- the time of optimum fertility of the ovum is very short (2-4 hours)
- ovulation time varies from 5 – 16 hours after the end of standing heat (10–11 hours average)
- fertile life of sperm is limited to 28 hours in the female reproductive tract
- timing of breeding is critical for optimum fertilization rates
- optimum conception rates have been reported during the last half hour of standing heat period
- The following are recommended:
  - if standing heat is first observed in the morning, breed in the afternoon or evening
  - if standing heat is first observed in the afternoon or evening, breed the next morning
- These recommendations are based on
  - average heat period of 18 hours
  - average ovulation time of 10 to 11 hours after the end of heat
  - first observed standing heat was near the beginning of the standing heat period

Dairy Cattle Management

Breeding Management

- cows come to estrus the whole year
- estrus lasts for 18 hours and recurs every 3 weeks
- gestation period is about 9 months
- dairy cows are usually hand-mated or inseminated artificially
- it is desirable to use semen from outstanding or proven sires
- heifers are sometimes inseminated at 15 months, but grow better if not served until at least 18 months
- duration of lactation depends on age, breed and feeding
- usually 5-7 months for first timers
- adult may last for a year
- cows are usually kept in the herd until 5-6 years
- dairy cows should be allowed a period of at least 2 months between lactation to

enable them to replenish fat and protein from the previous lactation
- advisable to dry the cows two months before her next calf is due
- during this time, globulins accumulate, serve as carriers of antibodies in the colostrum
- one way to dry cows is to reduce the number of milkings to one daily and her rations curtailed; later, she is milked every other day
- if not milked at frequent intervals, the cow stops producing milk
- cows should not breed right away after they have freshened since the uterus must undergo preparation for the next pregnancy
- ideal average days open is 85 days

Care of Calves
- after birth, a calf should be wiped dry
- membranes clinging to its mouth and nostrils must be removed
- navel dipped in disinfectant
- should be given colostrum to help resist any disease-causing microorganisms
- dairy operators castrate bulls and grow them for beef
- heifer calves are kept for one lactation to determine how much milk they produce
- calves are allowed to nurse from their dams from 1–3 days of age
- for the first month, calves should get whole milk (about 4 liters divided into 3 feedings)
- grains and leafy hay are given to let them start eating dry feeds
- hastens rumen development
- for the next 6 weeks to 9 weeks, whole milk may be gradually replaced with skim milk
- after 4 weeks, the calf should begin to eat solid feed

Feeding Management
- to provide a ration that will encourage optimum economical milk production of acceptable composition while conducive to the health of the cows
- produce adequate supply of high quality forages at minimum cost per unit of nutrient

Forages
- vegetable feed for domestic animals
- relatively useless as nutrient source for humans and monogastrics
- since the entire plant is consumed, the cost per unit of nutrient from forages is usually much lower than the cost of unit nutrient from concentrate feeds
  - ▶ Pasture
  - ▶ Soilage
  - ▶ Silage
  - ▶ Hay
- primary constituent of dairy rations for physiological and economic reasons
- they can make up to 60-70% of total dry matter intake of dairy cattle
- dairy cattle must consume adequate amounts of fiber (min 15% of DM) to ensure adequate rumen function
- low consumption of fiber may result in decreased milk fat percentage and decreased ration digestibility
- second step involves supplementing the available forage with a combination of concentrate feeds that will provide the cow with a balanced ration at the lowest total feed cost per unit of milk produced
- The ration should
- contain *ad libitum* amount of fresh, clean water

- contain a total ration crude fiber level on DM basis of 15- 24%
- 15-19% for early lactation or high producing cows
- 19-25% for late lactation or low producing cows
- contain a total ration crude protein on DM basis of 12-16% for early lactation cows and 12-14% for late lactation
- be within the DM intake capacity of the cow
- varies widely with individual cows but generally ranges from 1.5-3.6% of BW depending on milk production level

Health Management

- milk secretion is a process that can be carried out by the female with maximum efficiency only if she is healthy
- Dairy cattle are susceptible to a wide variety of diseases
  - ▶ Foot-and-Mouth Disease
  - ▶ Tuberculosis
  - ▶ Brucellosis
  - ▶ Mastitis – most troublesome condition, the inflammation of the udder destroys tissues and impedes milk production
- objective is to minimize culling and mortality while maintaining a healthy herd
- herd health programs are centered on the prevention rather than treatment of diseases
- basic principles for an effective herd health program includes:
  - ▶ Prevention of disease problems
    - more effective and profitable than treatment
    - can be achieved by
      - ▶ preventing exposure to disease-producing organisms
      - ▶ cleanliness and good sanitation
      - ▶ isolation of incoming animals
      - ▶ maintaining high level of resistance
      - ▶ vaccination
      - ▶ good nutrition
      - ▶ comfortable environment
      - ▶ reducing the spread of diseases
      - ▶ isolation of animals that contract or are suspected of contracting contagious disease
      - ▶ accurate diagnosis and prompt treatment
      - ▶ keen observation to detect minor abnormalities before they become serious problems
      - ▶ maintain accurate health record system
      - ▶ aids in diagnosis of problems
      - ▶ alert potential problems

Milk Production

- after parturition, the level of milk production rises rapidly
- peak of lactation is reached in 2 – 6 weeks, then slowly declines until drying off
- **Milk yield** is closely dependent upon lactation length
- a cow that is calving annually and provided with necessary annual vacation should milk for 300 days

Milking

- depending on the number of cows, farmers milk their cows either by hand or by machine

Length of actual milking

- it will take an average of 1 ½ to 2 hours to milk 10 cows by hand depending on the skill of the milker

- using a herringbone system of machine milking, a dairy man can milk 40 cows in an hour

Pasture Management

Forage Crops

- basis of nutritional programs in ruminant livestock in the Philippines
- most of the cattle (90%) and carabao (100%) raised by smallhold farmers are fed solely on forage, with minimal to no concentrates
- Main sources are
  - ▶ weeds or indigenous/native vegetation
  - ▶ farm by-products or residues
  - ▶ sown pastures
  - ▶ native tropical grasslands are mainly composed of short-
  - ▶ season species which grow fast and tall during the rainy
  - ▶ season
    - after the rainy season, plants develop tall, flowering stems which decrease in protein and increase in fiber
    - the feeding value of mature grasses is extremely low to the point that the animals do not get their maintenance requirement
    - native grasses are usually adapted to low soil fertility thus fertilizer application will not improve feed value
    - native grasslands have almost complete absence of legumes

Improved Pasture

- The value of forage species is measured by its ability to supply the animal with energy, protein, vitamins, and minerals
- Feed value of native species and farm by-products is low
- There is now a wide range of forage species (both grasses and legumes) available to replace native vegetation

Grasses

- *Brachiaria mutica* – Para Grass
- *Brachiaria decumbens* – Signal Grass
- *Brachiaria humidicola* - Koronivia Grass
- *Panicum maximum* – Guinea Grass
- *Pennisetum purpureum* – Napier Grass
- *Dicanthium aristatum* – Alabang X
- *Cynodon plectostachyus* – Star Grass

Legumes

- *Leucaena leucocephala* – Ipil-ipil
- *Centrosema pubscens* – Cetrosema
- *Calopogonium mucunoides* – Calopo
- *Macroptilium atropurpureum* – Siratro
- *Pueraria phaseoloides* – Kudzu
- *Stylosanthes guianensis* – Common Stylo
- *Stylosanthes hamata* – Carribean stylo

Philippine Grasses

- *Saccharum spontaneum* – Talahib
- *Imperata cylindrica* – Cogon
- *Themeda triandra* – Bagokbok
- *Capillipedium parviflorum* – Misamis grass
- *Chrysopogon aciculatus* - Amorseco

V. GOAT AND SHEEP PRODUCTION

Goat scientific name: *Capra hircus*

- known as “biological herbicide” due to its browsing ability (browser)
- diet – 40% grass and 60% forbs (shrubs and herbs)
- capable of nibbling bark of trees

- have mobile lips
- walk long distance in search of food
- selective in terms of feed preference (eats young and shoot first)

Sheep scientific name: *Ovies aries*
- "biological lawnmower" (essentially grazer)
- flocking instinct – pecking order
- less selective of feed offered than goats

Basic differences between goat and sheep

- Goat production is one of the ideal farm enterprises if properly managed in the farm

- Goats are multi-purpose ruminants producing 58.4% milk, 35.6% meat, 4.3% hide and 1.7% fiber

Sheep Breeds

Barbados Black Belly – originated in Barbados island with African ancestry; adapted to wide range of environment; high reproductive efficiency; hair type: sweet mutton; black color covers underparts completely extending up the neck and down the insides of the legs

Priangan – originated in Indonesia; primarily for ram fighting and meat; thin-tailed; often lacks external ears

Shropshire – originated in England; wool-type; believed to be one of the ancestors of the Philippine sheep

Suffolk – originated in England; wool-type; meat, dark colored face and legs

Merino – originated in Spain; finest wool producer' the other ancestor of Philippine sheep

Goat Breeds

A. Dual purpose

Anglo-Nubian – basically a tropical breed successfully adopted to grow in the Western countries; distinguishing features are drooping pendulous ears and a Roman nose

Boer –raised for meat and grow more rapidly than other goat breeds; have a light-colored body and a distinctive red head

	Goat	Sheep
Scientific name	Capra hircus	Ovies aries
Chromosome number	60	54
Sounds made	Maaa	Baaa
Tail posture/carriage	Upward	Downward
Feeding behavior	Partly browser	Purely grazer
Social behavior	Individualistic	Flocking instinct
Long hair growth	Beard	Mane
Skin covering	Mostly hair	Mostly wool
Presence of horns	Naturally horned	Naturally polled
Presence of scent glands in males	Base of horn; beneath tail	Between hooves
Growth behavior of horn	Narrower; upright, less curved	Curl in loops at sides of head

B. Dairy breeds

Saanen – originated in Switzerland; pure white to off-white in color and has the highest milk production

Toggenburg – from Switzerland; smaller than the Nubian and Saanen; distinguishing features are markings on the face, legs and tails; erect ears like the Saanen

Alpine – a European breed; color ranges from off-white to red to black

La Mancha – from Spain/Oregon; very distinctive ear types "gopher ears", "elf ear"

Stock Selection

- Does – selection can be based on the number of offspring weaned per year/doe, mortality, length of productive life and incidence of major defects
- Bucks – blood composition, constitution and vigor, breeding quality and aggressiveness
  - ▶ it is recommended to have a minimum of two purebred or crossbred bucks of different breeds; generally, buck-doe ratio is 1:35

Management

- it is usual to see an offspring at the side of the mother even when rearing a kid of its own
- pack character is very evident, with the oldest buck or doe on the highest part of the sleeping area
- prefer an elevated area for resting; the arrangement and feature of the housing, including management practices, should be adapted according to these characteristics
- can be expected to live up to 13-15 years, with an average economic lifespan of 6-8 years
- in the Philippines, does come in heat year round with an average kidding interval of about 8-9 months

Housing

- goats are afraid of rain and wetness because they make them prone to pneumonia
- goats prefer to sleep in elevated areas, hence, the need for elevated sleeping platform, like a stair-type arrangement
- flooring should be elevated at least about 15º to facilitate drainage and cleaning
- pens for lactating does, kids, growers and bucks should be separate
- the buck pen should be situated such that it is always visible to the breeding does, but far enough to prevent the tainting of milk with goat smell if it is to be sold

• Types of Housing

- **Shed** – free movement in or out
- with feeding and watering troughs, mineral feeders and grain bunks

- **Pen – barn type**
- stall barns for individual confinement
- confined housing (group pen for same size of goats)
- feed and water should be protected from spoilage and not mess up the pen

Minimum floor space requirement for intensive production

Animal	Weight, kg	Floor space (m^2/animal)		
		Solid floor	Slatted	Open yard
Doe/Ewe	35	0.8	0.7	2
Doe/Ewe	50	1.1	0.9	2.5
Doe/Ewe	75	1.4	1.1	3
Kid/Lamb		0.4-0.5	0.3	0.4
Buck/Ram		3	2.5	

Minimum space requirement

a. floor
b. exercise lot or loafing area
   - 3 m^2/animal
   - a loafing area, fenced beside the goat house, must be provided complete with feeding racks and water troughs; must be continuous with the goat house to allow animals to loaf when preferred

Functional requirement

- **Pens** (for pen-barn type housing)
  - height of pen wall and gate – not less than 1.2m

- **Pen facilities**
  - feeding trough and hay racks
  - watering trough, 300mm space per 15-25 head; or 1 bowl or nipple per 50 head

Computation of total floor space

- Basis
  - number of breeding females
  - reproductive parameters
    - ▶ conception rate (80%)
    - ▶ kidding interval (8 mos)
    - ▶ average kidding size (1.5)
    - ▶ disposal age (1 yr old)
    - ▶ annual replacement rate (20%)
    - ▶ livability rate (to 1 yr of age)
  - minimum floor space requirement

Animal	Weight (kg)	Floor space m^2	
		Pregnant	Lactating
Doe/Ewe	50-70	1.3	2
Doe/Ewe	>70	1.6	2.3

- **cogon** and **nipa** roofing materials are preferable in the Philippines
- ventilation is of utmost importance to prevent pneumonia due to excessively warm and humid interior and sudden changes in temperature
  - allow 0.5 to 1 ft clearance between floor and wall
  - maintain interior temperature of 28ºC to 30ºC; above 30ºC, appetite is affected

	Floor area (m^2)	Feeding space (linear m)
Does, bucks and adults	0.50-1.50	15.24-25.40
Growing	0.50-0.75	10.16-15.24
Kids	0.20-0.50	7.62-12.70

- **lighting** – goats consume up to 30% of the day's intake during the night if barn is lighted

Fencing

- nine-eye hog wire is the cheapest and most effective
  - post staking distance should be every 2m – goats pound their feet and scrape their bodies on fences, so these have to be sturdy
- barbwire fence – at least 4 strands

Breeding and Management

Breeding characteristic	*Bos Taurus*	*Capra hircus*	*Ovies aries*
Age at puberty, mos	8	5-6	7-8
Age at first breeding, mos	15	8-10	12
Estrus cycle, days	18-24	18-24	15-19
Estrus duration, hrs	18	24-72	24-72
Post-partum estrus, hrs	40-60	60	17
Gestation period, days	283	150	150

Breeding characteristics of goats

Reproductive Phenomena

Sexual Maturity – 5-6 mos if well-managed and well-fed

Estrous Cycle – regularly cycling, becomes in-heat every 18–24 days with an average of 21 days

Estrous Duration – heat period usually ends after 18 hrs from onset

- **Signs of estrous**
  1. receptive to mounting
  2. mounting other goats
  3. mucous discharge from vulva; swollen vulva
  4. frequent urination, nervousness and lack of appetite

Gestation Period – 5 mos

Age at First Breeding – while females mature at 5-6 mos old, they are not supposed to be bred until they reach 8- 12 mos; buck are allowed to breed at 10-12 mos old

Male-to-female ratio – 1:25 (1–yr old buck)

Care of Breeder Buck

- immediately separated from the herd after weaning at 3-4mos
- selected at 8-10mos

Care of Dry and Pregnant Does

- if being milked, dry (stop milking) at least 1 ½ -2 mos before kidding; will give her enough reserve for the next lactation
- place doe in a separate kidding pen 1 wk before kidding
- it should be quiet in the kidding area; it may be necessary to help the doe during kidding, especially the native doe bred with a purebred buck
- dystocia is common with upgrading; the presentation should be right before pulling the kid; with anterior presentation, both front legs and head are presented; in posterior presentation, both hind limbs come out at the same time
- kids, particularly oversized ones, should be pulled out with an even, continuous pressure

Care of the Lactating Doe and Newborn Kids

- the kid's mouth, nose and eyes should be wiped with a clean, dry cloth and the thoracic area massaged to initiate breathing immediately after delivery; normally done by the doe, but may be too weak to do it; no mucous should be clogging the nostrils
- the kids should be able to suck milk within an hour; very weak kids may be given colostrum through stomach tube or feeding bottle
- reluctant first time does may be restrained for first sucking to relieve udder pain; if colostrum is not fully consumed, stopping (manually milking out excess) is necessary to prevent mastitis
- the placenta must come out within 24 hours after fetal expulsion

- the umbilical cord must be tied with a sterile string and the cut portion applied with disinfectant (tincture of iodine)

- the kids should be allowed to suckle in the first 4 to 5 days; if the doe is to be milked, the kids have to be separated and bottle-fed; if the doe is not to be milked, she can be taken out of the pen for feeding and returned to the kid three times a day and the whole night

- when the doe comes into heat, introduce her to the buck, not vice versa

- two services a day for 2 days is optimum; if the doe does not conceive, heat may return in 8 to 12 days

- higher conception – accomplished in secondary heat; with successful breeding, milk production drops after 1 month and the right side of the abdomen starts to fill up

Milking

- like cattle, goats adapt to a routine; milking periods must be established and strictly adhered to
- the milking process should not be delayed or advanced
- the same personnel should be assigned to avoid does from withholding their milk
- milk quickly and continuously; milk letdown is initiated by washing the udder with lukewarm water and wiping with a clean towel
- feed concentrates during milking, to serve as incentives for goats to enjoy and look forward to

Care of Weanlings and Growing Kids

- place the weaned kids in a separate pen, if possible, according to size
- castrate male kids to be raised for meat as early as possible, within the first month
- females to be raised for milking are checked for excess teats for removal
- dehorn when buds reach the size of a fingernail; horn buds usually appear within the first to third month
- males are separated from the females at 4 months old, as goats sometimes reach puberty at this age
- females are bred at 8-10 months; bucks can start at the same age

Anestrus – the failure to come in heat
- common among high producing does
- routine administration of oxytocin right after kidding and before weaning (5 days) aids in faster expulsion of the placenta, uterine fluids and in the rapid regression of the uterus
- routine supplementation with vitamins A, D and E contribute to reproductive well-being

Goat Artificial Insemination

- utilizes far-away proven bucks for impregnating in-heat does
- successfully done at National Rural Life Center (NLRC) in Dasmarinas, Cavite

Other Routine Management Practices

Hoof Trimming – under confinement, goats' hooves overgrow and have to be trimmed
- done using a rose pruner and a small curved knife
- untrimmed hooves cause lameness; bucks do not mount with sore feet

Dehorning

- a dehorned animal is more docile than a horned one; dehorning eliminates unnecessary injuries due to fighting
  - essential especially in milking
  - dehorn when horn buds appear at 2 to 4 months using hot iron cautery
  - a 1/2–inch GI pipe is an effective and cheap cauterizing material
  - chemical cautery is not recommended as it results in cauterized or burned tongues due to licking (goats tend to lick one another)

Tattooing, Ear Notching and Other Forms of Identification

- done to keep tract of individual animals
- ear notching is more common because of permanence and easy identification; use of plastic tags should be refrained from
- tattooing does not causes deformities but special tools needed may be costly

Recording – a well-kept recording system is necessary for a breeding program to succeed; the record must reflect all the essential data of individual animals

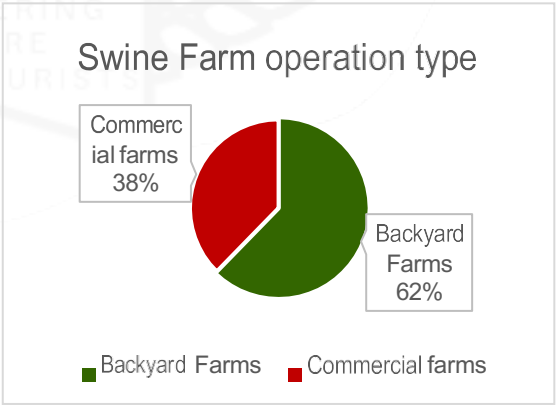
PHILIPPINE LIVESTOCK AND POULTRY INVENTORY & PRODUCTION REPORT
(as of April 1, 2020)
Philippine Statistical Authority

1. SWINE Population (number of heads) REPORT per region

	Population
TOTAL PHILIPPINES	12,342,023
NATIONAL CAPITAL REGION (NCR)	..
CORDILLERA ADMINISTRATIVE REGION (CAR)	256,422
REGION I (ILOCOS REGION)	600,974
REGION II (CAGAYAN VALLEY)	409,133
(1) REGION III (CENTRAL LUZON)	1,838,409
(2) Region IV-A (CALABARZON)	1,530,002
MIMAROPA REGION	587,045
REGION V (BICOL REGION)	874,770
(3) REGION VI (WESTERN VISAYAS)	1,224,836
REGION VII (CENTRAL VISAYAS)	1,111,329
REGION VIII (EASTERN VISAYAS)	266,082
REGION IX (ZAMBOANGA PENINSULA)	581,228
REGION X (NORTHERN MINDANAO)	1,113,974
REGION XI (DAVAO REGION)	893,363
REGION XII (SOCCSKSARGEN)	796,281
REGION XIII (CARAGA)	215,094
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	43,081

2. SWINE volume of production (metric tons live weight) REPORT per region

REGION	Production (MT, live weight)
PHILIPPINES	571,259.23
CAR	6,744.44
Ilocos Region	24,238.20
Cagayan Valley	17,420.48
(1) Central Luzon	114,105.51
(2) CALABARZON	90,330.75
MIMAROPA Region	17,768.68
Bicol Region	34,528.67
Western Visayas	48,238.90
Central Visayas	46,815.86
Eastern Visayas	16,449.47
Zamboanga Peninsula	20,493.12
(3) Northern Mindanao	52,232.83
Davao Region	39,091.00
SOCCSKSARGEN	30,933.18
Caraga	8,424.83
ARMM	3,443.31

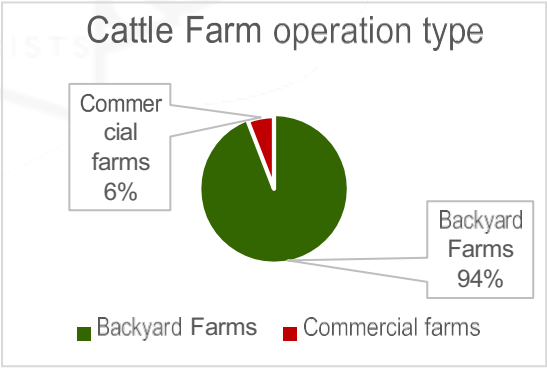


3. Cattle population (number of heads) report per region

REGION	NUMBER OF HEADS
PHILIPPINES	2,541,959
CORDILLERA ADMINISTRATIVE REGION (CAR)	55,024
(1) REGION I (ILOCOS REGION)	311,106
REGION II (CAGAYAN VALLEY)	187,163
REGION III (CENTRAL LUZON)	199,187
(3) Region IV-A (CALABARZON)	268,354
MIMAROPA REGION	67,541
REGION V (BICOL REGION)	112,581
REGION VI (WESTERN VISAYAS)	246,650
(2) REGION VII (CENTRAL VISAYAS)	287,262
REGION VIII (EASTERN VISAYAS)	19,449
REGION IX (ZAMBOANGA PENINSULA)	111,254
REGION X (NORTHERN MINDANAO)	231,687
REGION XI (DAVAO REGION)	134,010
REGION XII (SOCCSKSARGEN)	194,065
REGION XIII (CARAGA)	20,702
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	95,924

4. CATTLE volume of production (metric tons live weight) REPORT per region

Region	Production
PHILIPPINES	61,024.00
CAR	1,093.00
Ilocos Region	7,177.00
Cagayan Valley	3,805.00
Central Luzon	4,288.00
CALABARZON	4,576.00
MIMAROPA Region	2,373.00
Bicol Region	4,336.00
Western Visayas	5,645.00
Central Visayas	6,171.00
Eastern Visayas	464.00
Zamboanga Peninsula	2,731.00
Northern Mindanao	9,803.00
Davao Region	2,772.00
SOCCSKSARGEN	3,507.00
Caraga	334.00
ARMM	1,949.00



5. CARABAO population (number of heads) report per region

REGION	POPULATION
PHILIPPINES	**2,865,715**
CORDILLERA ADMINISTRATIVE REGION (CAR)	88,036
REGION I (ILOCOS REGION)	178,438
(3) REGION II (CAGAYAN VALLEY)	220,592
(2) REGION III (CENTRAL LUZON)	232,243
Region IV-A (CALABARZON)	178,901
MIMAROPA REGION	135,011
(1) REGION V (BICOL REGION)	316,528
REGION VI (WESTERN VISAYAS)	293,017
REGION VII (CENTRAL VISAYAS)	195,119
REGION VIII (EASTERN VISAYAS)	206,248
REGION IX (ZAMBOANGA PENINSULA)	146,813
REGION X (NORTHERN MINDANAO)	127,284
REGION XI (DAVAO REGION)	143,922
REGION XII (SOCCSKSARGEN)	199,895
REGION XIII (CARAGA)	80,749
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	122,919

6. CARABAO volume of production (metric tons live weight) REPORT per region

REGION	Production
PHILIPPINES	29,812.04
CAR	947.06
Ilocos Region (1)	2,590.42
Cagayan Valley	1,776.00
Central Luzon	1,068.75
CALABARZON	1,351.20
MIMAROPA Region	1,564.35
Bicol Region (2)	2,467.49
Western Visayas	5,402.43
Central Visayas	1,594.67
Eastern Visayas	1,036.36
Zamboanga Peninsula	2,293.67
Northern Mindanao	1,508.33
Davao Region	2,275.23
SOCCSKSARGEN (3)	2,424.28
Caraga	618.11
ARMM	893.69

7. GOAT population (number of heads) report per region

REGION	POPULATION
PHILIPPINES	3,813,454
CORDILLERA ADMINISTRATIVE REGION (CAR)	50,492
REGION I (ILOCOS REGION) (3)	470,040
REGION II (CAGAYAN VALLEY)	94,608
REGION III (CENTRAL LUZON)	337,842
Region IV-A (CALABARZON)	261,276
MIMAROPA REGION	208,532
REGION V (BICOL REGION)	159,631
REGION VI (WESTERN VISAYAS) (2)	517,049
REGION VII (CENTRAL VISAYAS) (1)	536,614
REGION VIII (EASTERN VISAYAS)	37,738
REGION IX (ZAMBOANGA PENINSULA)	132,181
REGION X (NORTHERN MINDANAO)	217,824
REGION XI (DAVAO REGION)	308,013
REGION XII (SOCCSKSARGEN)	219,005
REGION XIII (CARAGA)	50,150
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	212,459

8. GOAT volume of production (metric tons live weight) REPORT per region

Region	Production
PHILIPPINES	19,071.00
CAR	167.00
Ilocos Region (2)	2,564.00
Cagayan Valley	358.00
Central Luzon (1)	2,619.00
CALABARZON	754.00
MIMAROPA Region	547.00
Bicol Region	738.00
Western Visayas	1,841.00
Central Visayas (3)	2,521.00
Eastern Visayas	164.00
Zamboanga Peninsula	736.00
Northern Mindanao	1,841.00
Davao Region	1,137.00
SOCCSKSARGEN	1,508.00
Caraga	207.00
ARMM	1,369.00

9. CHICKEN INVENTORY by type per region

REGION	BROILER	LAYER	NATIVE/ IMPROVED
PHILIPPINES (TOTAL)	56,386,934	41,202,461	80,675,556
CORDILLERA ADMINISTRATIVE REGION (CAR)	25,415	207,485	1,330,223
REGION I (ILOCOS REGION)	4,571,955	1,252,145	4,851,724
REGION II (CAGAYAN VALLEY)	824,864	838,361	4,274,690
REGION III (CENTRAL LUZON)	13,787,464	8,334,853	6,560,208
Region IV-A (CALABARZON)	9,790,990	14,694,560	2,626,504
MIMAROPA REGION	191,528	284,761	3,862,836
REGION V (BICOL REGION)	2,505,621	664,141	5,581,773
REGION VI (WESTERN VISAYAS)	6,019,083	1,443,459	12,448,333
REGION VII (CENTRAL VISAYAS)	6,387,187	3,188,525	8,613,369
REGION VIII (EASTERN VISAYAS)	251,348	488,322	1,385,011
REGION IX (ZAMBOANGA PENINSULA)	1,483,796	952,977	4,611,189
REGION X (NORTHERN MINDANAO)	6,142,550	3,824,047	9,656,028
REGION XI (DAVAO REGION)	1,772,589	2,036,947	6,635,576
REGION XII (SOCCSKSARGEN)	2,375,752	2,350,393	4,948,851
REGION XIII (CARAGA)	255,766	599,355	1,485,875
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	1,026	42,130	1,803,366

10. DUCK INVENTORY per region

PHILIPPINES (TOTAL)	**11,794,398**
CORDILLERA ADMINISTRATIVE REGION (CAR)	301,724
REGION I (ILOCOS REGION)	343,128
REGION II (CAGAYAN VALLEY)	1,062,125
REGION III (CENTRAL LUZON)	4,076,013
Region IV-A (CALABARZON)	409,435
MIMAROPA REGION	204,383
REGION V (BICOL REGION)	578,444
REGION VI (WESTERN VISAYAS)	1,411,207
REGION VII (CENTRAL VISAYAS)	183,546
REGION VIII (EASTERN VISAYAS)	245,352
REGION IX (ZAMBOANGA PENINSULA)	297,517
REGION X (NORTHERN MINDANAO)	457,580
REGION XI (DAVAO REGION)	524,789
REGION XII (SOCCSKSARGEN)	1,453,793
REGION XIII (CARAGA)	111,182
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	134,180

11. POULTRY & EGG Production (2019) per region

REGION	CHICKEN	CH. EGG	DUCK	DUCK EGG
PHILIPPINES	1,927,414	583,234	30,104	49,569
CORDILLERA ADMINISTRATIVE REGION (CAR)	6,622	4,072	804	639
REGION I (ILOCOS REGION)	84,231	19,578	1,320	1,048
REGION II (CAGAYAN VALLEY)	55,372	14,787	2,512	2,669
REGION III (CENTRAL LUZON)	699,655	118,182	10,792	21,030
Region IV-A (CALABARZON)	343,265	174,939	647	3,812
MIMAROPA REGION	11,174	6,942	416	560
REGION V (BICOL REGION)	54,884	14,836	1,117	1,665
REGION VI (WESTERN VISAYAS)	117,439	35,939	2,798	4,725
REGION VII (CENTRAL VISAYAS)	118,628	53,863	291	344
REGION VIII (EASTERN VISAYAS)	62,322	4,547	770	395
REGION IX (ZAMBOANGA PENINSULA)	36,476	16,185	313	1,847
REGION X (NORTHERN MINDANAO)	170,021	49,204	1,850	4,451
REGION XI (DAVAO REGION)	81,090	31,651	1,057	1,351
REGION XII (SOCCSKSARGEN)	65,563	27,145	4,384	3,536
REGION XIII (CARAGA)	15,513	8,017	185	582
AUTONOMOUS REGION IN MUSLIM MINDANAO (ARMM)	5,161	3,347	847	915

References

BONDOC, Orville L. 2008. Animal Breeding: Principles and Practice in the Philippine Context. The University of the Philippines Press. Quezon City. 386 pp.

CULLISON A.B. 1982. Feeds and Feeding. Prentice Hall Company. 626 pp.

ETCHES, Robert J. 1996. Reproduction in Poultry. CAB International. UK. 318 pp.

FALCONER, Douglas S. 1981. Introduction to Quantitative Genetics. Second Edition. Longman. London and New York. 340 pp.

FRANDSON R. D. 1985. Anatomy and Physiology of Farm Animals. Lea and Febiger, USA

HANNAFORD-SHAFER, N. T. 1975. Genetics for the Breeder and Exhibitor of Poultry. Department of Agriculture, Victoria. 16 pp

IBARRA, P.I. 1983. Meat Processing for Small and Medium Scale Oerations. UP Los Baños, College, Laguna 418 pp.

JOHANSSON, Ivar at Jan RENDEL. 1968. Genetics and Animal Breeding. Oliver and Boyd, Edinburgh. 489 pp.

JULL, Morley A. 1952. Poultry Breeding. John Wiley and Sons. New York. London.

LASLEY, J.P. 1978. Genetics of Livestock Improvement. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 492. Pp.

MAYNARD, A.M., J.K. LOOSLI, H.F. HINTZ, and R.G. WARNER. 1979. Animal Nutrition. McGraw-Hill Book Company: New York. 602 pp.

NALBANDOV, Andrew V. 1976. Reproductive Physiology of Mammals and Birds. Third Edition. W. H. Freeman and Company. San Francisco, USA. 334 pp.

VAN VLECK, Lloyd Dale; Emil John POLLAK and Elizabeth A. BRADFORD-OLTENACU. 1987. Genetics for the Animal Sciences. W. H. Freeman and Company. New York. 391 pp.

VILLEGAS, V.E. 1969. Fundmentals of Animal Husbandry. Authors Associated, Inc. Manila. 304 pp.

WILLIS, Malcolm B. 1991. Dalton's Introduction to Practical Animal Breeding. Third Edition. Blackwell Science Limited. Oxford. 159 pp.