

**EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING**
Revised for
ACCESS TO APPRENTICESHIP

**SCIENCE SKILLS
BASIC ZOOLOGY**

**AN ACADEMIC SKILLS MANUAL
for**

The Food Preparation Trades

This trade group includes the following trades:

Baker, Cook and
Retail Meat Cutter

*Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities*

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

SCIENCE SKILLS

BASIC ZOOLOGY

*An academic skill required for the study of the
Food Preparation Trades*

INTRODUCTION

Humans, like all animals, must obtain needed calories and nutrients by eating food. Only plants can get their energy from the sun and their nutrients from the soil and air. Animals use the energy and nutrients contained in plants to supply the materials used in growth, development and repair.

Some animals such as cattle get all their food by eating plants. These animals are called herbivores. Other animals, called carnivores, get their nutritional requirements by eating herbivores, the animals that feed on plants. The third group eats both plant and animal food. The animals in this group, which includes humans, are called omnivores.

The different foods people eat are complex mixtures of organic molecules. Fruits, vegetables and grains contain starch, fibre, water with dissolved sugars, vitamins and minerals. Foods derived from animals consist of flesh (muscles), blood, bones, skin and organs.

Food preparation workers handle many different kinds of foods of both plant and animal origin. Meat cutters are responsible for preparing cuts of meat, poultry and fish so that they can be sold to the public. In order to prepare meat from a carcass to a stage where it is ready to be packaged, a meat cutter should have some knowledge of basic zoology.

This knowledge will be helpful in the following areas:

- ◆ Recognizing the different species of animals used for food.
- ◆ Identifying the different parts of an animal's body to assist in cutting, deboning and classifying meats.
- ◆ Understanding the difference between muscle, bone and connective tissue.
- ◆ Recommending appropriate cooking methods for different types of meat and fish.

This skills manual looks at the how animal species are classified. It also examines the different types of animal tissues, especially those located in the skeletal and muscular systems. The following topics are covered:

- ◆ Animal classification
- ◆ Animal tissues
- ◆ Muscular and skeletal systems

ANIMAL CLASSIFICATION

When you barbeque shrimp one day and then steak the next, you are aware that the shrimp and beef look and taste different. What exactly is the difference between a steer and a shrimp? Because there is such a wide variety of living organisms, scientists decided that to understand the relationship between living things, similar organisms should be classified together. They based their early classification on several criteria:

- Organisms that are similar in appearance and body organization are probably closely related.
- Organisms that behave in similar ways are probably closely related.
- Organisms that can breed with each other are closely related.

Organisms were placed in categories that broadened from closest to most distant relatives.

- Similar individuals are categorized as belonging to the same *species*.
- Similar species are in the same *genus*.
- Similar genera are placed in the same *family*.
- Families are grouped into *orders*.
- Orders are grouped into *classes*.
- Classes are grouped into *phylum*.
- The largest groupings are called *kingdoms*.

An individual animal can be identified by the name of the smallest group to which it belongs. This is the name of the species. Each species is given a two part name. The first part lists the genus to which the species belongs. The second part of the name lists the specific group to which the individual belongs.

Let's look at how this works by naming the species of the common type of pig that is farmed in Canada for pork products.

- The two part name of this pig is *Sus domestica*.
- There are many different types of pigs around the world.
- They all belong to the genus *Sus*.
- However, only individuals that are part of our agricultural pig grouping have the second name, *domestica*.
- So when you see a pig that is identified as *Sus domestica*, you know the species (and the genus) of the pig.
- Notice that the first part of the name is capitalized and it is written in italics.

This way of identifying individuals can be useful in the food preparation trade. When you buy fish, the price can vary considerably depending on the species.

- Black sea bass, *Centropristis striata*, is a desirable species and is usually quite expensive.
- The Chilean sea bass, *Dissostichus eleganoides*, is usually less expensive.

- If you are paying the price for black sea bass, you probably want to know you are getting the species of fish you paid for.

Tests carried out on fish species offered for sale, have found that many were mislabeled.

- Fish can be identified by species using genetic tests.
- Similar to the tests used in forensic investigations, this process takes DNA from the fish and compares it to the DNA of different fish species.
- When a DNA match is found, the species of the sample can be identified.
- This is a very accurate system but you have to understand the concept of what a species is and how it is named in order for it to be useful. .

The animals processed in the meat cutting trade all belong in the animal kingdom.

- This division includes fish and seafood, chicken and turkey, and beef, pork and lamb.

Most of the other food products come from the plant kingdom.

Workers in the food industry must also be aware of microorganisms, which belong in their own kingdom.

- Some microorganisms can cause illness in people.
- They will grow in food, especially meat products, if the environment is suitable.
- Certain sanitary regulations must be followed to prevent food from becoming contaminated with harmful bacteria.

Example: Meat is kept chilled because harmful microorganisms usually grow better at warmer temperatures. Meat packaging facilities are cleaned every day to prevent bacteria from spreading.

The common chicken is a very popular meat product. This species, like all mammals, is part of the system used to classify animals. Let's look at the different levels of classifying a chicken.

- A chicken is part of the kingdom Animalia.
- It belongs to the phylum Chordata.
- A chicken is part of the subphylum Vertebrata.
- Its class is Aves, which identifies all birds.
- The order of chickens is Galliformes. These are ground feeding, heavy bodied birds that includes turkey, quail and pheasants, besides chickens.
- Chickens belong to the family Phasianidae.
- The genus name is Gallus. This is the same name as the second part of the species name.
- So chickens belong to the species *Gallus gallus*.
- Because chickens are a domesticated subspecies, their full name is *Gallus gallus domestica*.

This system of naming species and placing them into larger categories has been very useful. If you know that two animals such as chickens and turkeys are placed in the same order, you can expect them to be more similar to each other than more distantly related animals.

Until recently, classification was based on comparing the structure and function of the different parts of a plant or animal. However, it has sometimes been difficult to identify the relationship between more distant categories based on similarity of body organization and behavior.

Example: Both birds and bats can fly but they are not closely related. They belong to different classes. Birds belong to the class Aves while bats belong to the class Mammalia.

A better way of relating organisms arose once the connection between genetic similarity and closeness of relationship became apparent. This led to the following system:

- Organisms that have a recent common ancestor are closely related and are grouped more closely together.

All the species used for meat production belong to the animal kingdom. This is a very large category that includes creatures as diverse as small insects and worms to large mammals. The animals that are eaten by people range from shellfish such as lobsters and scallops, which have their supporting shell on the outside, to hooved animals such as pigs and cattle, which have an internal supporting skeleton.

When we talk about the larger animals that provide red meat, we also refer to them as mammals, which is a class division. Mammals have a spinal cord, backbone and a complex brain. They breathe air, have a circulatory system in which blood is pumped by the heart and are covered in hair. The young developed inside the mother, who feeds them milk after they are born.

Humans belong to the class of mammals, which is officially written as Mammalia. We are further divided into the order Primates and the family Hominidae.

ANIMAL TISSUE

A mammal's body has a basic structure that it shares with other mammals; fish share a similar organization. Both mammals and fish have specialized cells organized into tissues. **Tissues** are groups of cells with a common structure and function. The parts of an animal that are most commonly eaten come from muscle tissue.

There are four main types of tissues:

- ◆ Epithelial tissue
- ◆ Nervous tissue
- ◆ Connective tissue
- ◆ Muscle tissue

Epithelial tissue

Epithelial tissue covers the outside of an animal's body and lines the inside cavities. The outside covering is called *skin*. This tissue protects against invaders, fluid loss and injury. Hair, which helps regulate temperature, grows on the skin. The inside cavities are usually lined with a moist coating called mucus.

The skin has different roles in different meat products:

- When animals such as beef or lamb are prepared for market, the skin or hide is removed. Sometimes it is used for leather or sheepskin products.
- The skin is left on hams and is called rind.
- Chicken is available with the skin left on or removed. Skinless chicken is easier to use in recipes but it can dry out more in cooking. Whole chickens are packaged with the skin so that the meat is covered for roasting but most chicken breasts are now sold with the skin removed.
- Fish skin is covered with scales that are often scraped off before it is sold. Frozen fish usually has all the skin removed while whole fish is often sold with the skin on.

Nervous tissue

The **nervous tissue** transmits information from one part of the body to another. Without the **brain** to coordinate the many different functions of the body, an animal will die. An electric shock to the head can disrupt the working of the brain, and kill or immobilize an animal at a slaughterhouse.

Connective tissue

Connective tissue acts to support and hold together the other tissues. It is made of a web of protein fibres. Collagen, the main protein in connective tissue, is the most abundant protein in the animal kingdom. Connective tissue holds the skin to the underlying organs and also holds the organs in place. It is used to pull on bones and muscles. Bones are strong, mineralized connective tissue. Other connective tissue stores fat, creating a cushion for body structures.

The connective tissues form a diverse group. These tissues have many different functions in an animal's body. Some important connective tissues include:

- ◆ blood and lymph,
- ◆ bone and cartilage,
- ◆ tendons, ligaments and fascia
- ◆ adipose (fat) tissue.

Blood circulates to all parts of an animal's body through arteries, veins and capillaries. The arteries bring freshly oxygenated blood from the heart and lungs, while the veins bring back waste products to be filtered out and removed. The small capillaries connect the two.

The **circulatory system** provides tissues and organs with nutrients and oxygen. It also carries away waste products such as carbon dioxide, which is produced from cell respiration.

After an animal is slaughtered, the blood is drained out.

- Blood can give a carcass an unappealing appearance and it is a good breeding ground for microorganisms.
- The large carotid artery and the jugular vein are cut in beef and lamb, while pork is drained through the anterior vena cava.
- The large blood vessels are removed, along with the head feet, excessive fat and internal organs before the carcass is cut and packaged.

Mammals have a skeleton made of **bone** and **cartilage** that holds up and supports the body. Bone is connective tissue made of the protein collagen, with hardened minerals embedded in it. Calcium, magnesium and phosphate make bone strong while the collagen keeps it from being too brittle.

Tendons and ligaments are tough. They are designed to pull on bones and muscles.

Fascia is a connective tissue found throughout the body. It surrounds muscles, blood vessels and nerves, binding them together the way plastic wrap holds packaged foods together.

Adipose tissue provides a protective layer. It is designed to store fat and cushion internal body structures. Adipose tissue has fat molecules embedded in a yellowish, fibrous support. For this reason, it is tough.

In contrast, the **intramuscular fat** that marbles red meat is a pure, white fat. This fat lends flavour and tenderness to the meat. Its development is encouraged in beef cattle by feeding them rich foods such as grain. At the same time, meat producers are concerned that too much fat in meat is linked to heart problems and obesity.

Because connective tissue is tough and stringy, one of the purposes of butchering is to remove as much of it as possible.

- Meat cutters usually remove most of the bone from a carcass before the meat is cut and packaged
- The outer fat and fascia are cut away.
- The tendons, ligaments and major blood vessels are removed.
- The fat that marbles meat is part of the muscle and can't be removed.

Muscle tissue

Meat is mostly composed of **muscle tissue**. Much of an animal's body is made of muscle. Muscles are attached to bone by tendons. When muscle tissue contracts, it moves the connected limb. Muscle contraction accounts for a large amount of the energy used by an active animal.

Organ systems

When different tissues work together as a structural unit for a common function, the unit is called an **organ system**. Usually there is a main tissue and other helping groups. For example, the main structural unit of the heart is a large muscle. The heart also consists of nerves, blood and connective tissue.

The main mammalian organ systems include the following:

- the **circulatory system**, which pumps blood around the body,
- the **respiratory system**, which provides the oxygen needed by the body,
- the **digestive system**, which digests and processes food which is eaten,
- the **nervous system**, which is controlled by the brain and uses nerve cells to send messages to different parts of the body,
- the **excretory system**, which balances the amount of fluid in the body and gets rid of waste products from the food we eat,
- the **muscular system**, which enables the body to move,
- the **skeletal system**, which gives support through bones, cartilage, tendons and ligaments.

We will look at the skeletal and muscular system in more detail.

MUSCULAR AND SKELETAL SYSTEM

Muscular system

The muscles that are attached to and surround the bone are called **skeletal muscle**. Other main muscles power the heart. Smooth muscle contraction happens without conscious thought. This involuntary muscle system controls muscle movements such as the breathing of the lungs, which are necessary to maintain life.

Skeletal muscle consists of long bundles of fibres that all run the same way. A single muscle fibre is made of smaller myofibrils with a repeating pattern of dark and light bands.

When a muscle contracts, the length of the bands become smaller. As the muscle contracts and shortens, it pulls the attached bone with it. Note that any work done by muscles happens when it contracts. See Figure 1.

Muscles work in pairs. When one muscle of the pair contracts and causes movement, the other muscle in the pair extends and relaxes. An extended relaxed muscle is passive and doesn't do any work.

There are two main types of muscles – fast twitch and slow twitch muscles.

- Fast twitch muscle fibres are used for short, rapid, powerful contractions.
- Slow twitch fibres are used in muscles that maintain posture, a process that is continuous.
 - Slow twitch muscles are used for slower, more sustained activity such as slowly walking while grazing.

Meat is often classified as red meat or white meat. Since meat comes from muscle tissue, it gets its colour from the muscle fibres. The colour of muscle comes from the amount of **myoglobin** present.

Myoglobin is a pigment similar to hemoglobin, the pigment that carries oxygen in the blood and which gives blood its red colour. Myoglobin binds iron and oxygen even more tightly than hemoglobin. It is present in slow twitch fibres, which enables them to take oxygen from the blood and use it to power the muscles over a long time.

Meat with myoglobin has a reddish colour. The redness varies with the species and the age of the animal. Generally, the meat of cows, sheep, goats and pigs is considered red while the meat of chicken and turkey is considered white. Veal is a red meat but is lighter in colour, as is most pork. Turkey and chicken have white meat on the breast and darker meat on the legs and drumsticks. Because white meat has become more popular, chickens and turkeys have been bred to have more breast meat.

When meat is cut for packaging, it is easier to cut along the fibres than across them. Sometimes the direction of cutting makes a difference in the texture and appearance of the meat.

Skeletal system

The skeleton systems consist of bone, cartilage, tendons and ligaments. It provides a scaffold that prevents the body from sagging. The bones provide a support to which the muscles can attach. This attachment also enables the muscles to move an animal. The skeleton also protects the internal organs, such as the lungs, from physical damage.

Meat animals have a bilateral skeleton, which means the skeleton is the same on the right and left sides. For example, there is a large femur leg bone in each leg. The vertebrae run down the middle of the back, protecting the spinal cord.

The different bones are joined together at **joints**. The joints allow great flexibility in how the body can move. The ends of major joints are made from cartilage, which is softer than bone. Bones are joined to each other by tough connective tissue called ligaments. The ligaments keep the bones from falling out of place.

When carcasses are being divided, it is easier to cut through the joints. The bones are hard because of the minerals deposited in them, while the joints consist of ligaments and joint fluid. Certain meats are prepared with the bone left in. Roasts usually are packaged with the bone remaining.

Fish also have bones that are often removed before the fish is sold. Because fish are also bilaterally symmetrical, the bones are the same on each side. When fish is filleted, the backbone is removed, along with the bones on each side.

Large muscles surround the bones. They are connected to the bones by tendons. Tendons, like ligaments and fascia, are made from the protein collagen. When the muscle fibres contract, the tendon pulls on the attached bone and causes it to move.

Domestic animals are raised so that they have a lot of muscle tissue, because that is the part of the animal that is eaten. Cattle raised on feedlots do not move much. Their muscles are softer and have more fat. There is also a market for cattle that are grass fed and free range chickens. Their muscles are tougher because they are being used while the animals move around to feed but the flavor is preferred by some people.

CONCLUSION

Humans must get all the energy and nutrients they need to stay healthy from eating food. The food material used in the food preparation trades comes from once living plants and animals. Plants and animals are divided into species as a way of identifying similar groups. Similar plants and animals belong to the same species. Each species name has two parts. The first part names the genus an organism belongs in. The second part gives the name of the species.

For example, cattle belong to the species *Bos primigenius*. Notice that the first name, the genus, is capitalized and that both names are italicized. There are many local breeds of cattle such as Angus, Shorthorn and Charolais. The different breeds belong to the same species but each breed has a variation in the quality of their meat.

The main meat animals, which include beef, pork, lamb, chicken, turkey, fish and seafood, all have a similar body structure. Their bodies are made of cells. Specialized cells are organized into tissues. Tissues are groups of cells that have a common structure and function. There are four main types of tissue – epithelial, connective, muscle and nervous tissue.

Different tissues work together to form the organ systems such as the circulatory system, which supplies the body with needed materials and removes waste products.

The tissues that are of the most concern in the meat cutting trades are the muscle and the connective tissue. The muscles are the part of the animal which is eaten. The connective tissues, such as the bone, are a part of the animal that is removed before it is cut, packaged and sold.

Answer the following questions by placing the correct answer in the blank space. Answers are on the last page.

bone	two	Tissues	tendons	contracts	food	fibres
minerals	red	species	connective	muscle	joints	

1. Humans can't make their own energy from the sun but must get it from the _____ they eat.
2. Organisms are classified according to the _____ they belong to.
3. Each animal's name has _____ parts, the genus name and the species name.
4. _____ are a group of cells with a common structure and function.
5. Mammals have a skeleton made of _____ and *cartilage* that holds up and supports the body.
6. Because _____ tissue is tough and stringy, one of the purposes of butchering is to remove as much of it as possible.
7. Bones are connected to each other at _____ .
8. Skeletal muscle consists of long bundles of _____ that all run the same way.
9. As a muscle _____, it pulls the attached bone with it.
10. The main part of an animal that is eaten comes from _____ tissue.
11. Slow twitch muscles are _____ in colour.
12. Muscles are attached to bone by _____ .
13. Bone has hardened _____ deposited in connective tissue..

ANSWER PAGE

1. food
2. species
3. two
4. Tissues
5. bone
6. connective
7. joints
8. fibres
9. contracts
10. muscle
11. red
12. tendons
13. minerals