

Chapter Seven

Protection, Support, and Movement:

What can go wrong?

This week, we are going to look at a few of the possible problems that may exist within the skin, muscles, and bones. We could spend months studying all of the disorders that may occur within these three different systems. However, it's probably best to give you a brief look at some of the more common problems that can occur and a few of the possible ways our bodies and our doctors can help in the recovery process.

First of all, always remember that our bodies are very good at fixing the problems they encounter!

Our bodies have a natural set of defenses which act to keep foreign invaders (such as bacteria and viruses) from entering and/or spreading within ourselves. And, in the times when our tissues are damaged by these invaders or through other means such as bruising or cutting, our bodies have a general response to repair the damaged tissues as well.

How is this done?

It generally occurs through a two-step process:

Inflammation and Regeneration



The process of **inflammation** involves swelling, redness, excessive warmth, and pain in the area that contains the damaged tissues. A buildup of fluid (**edema**) typically results in most inflamed areas as well which causes the noticeable symptom of swelling. These actions produce an environment which is not favorable for bacteria and viruses to grow and reproduce.

For example, bacteria and viruses can naturally be found on the surfaces of sharp objects. When we are accidentally cut by these objects, these damaging organisms can enter our body and easily find the resources needed for their growth and reproduction. An inflammatory response, therefore, attempts to keep these **pathogens** (harmful organisms) from spreading throughout the body by altering the tissue's environment.

The second step in the repair of damaged tissue is **regeneration**. During this stage the body attempts to restore homeostasis by replacing or repairing the damaged tissues so they may perform their normal functions. This stage actually occurs during the inflammatory response while the pathogens are being destroyed.

This entire chapter is devoted to the study of tissue damage in one form or another. Most of the time, the minor cuts and scrapes we receive are repaired naturally by our bodies and no trace of these damages can be found. It is without doubt that nearly all of us have experienced the misfortune of receiving a paper cut; however, it is unlikely that we can find any trace of these injuries a year after the fact. Unfortunately, some of our injuries are much more severe and visible traces of their occurrence can be found years later. By this, I am referring to the presence of **scars**.



Scars

As you learned in Chapter 3, our skin is made up of two layers: the outer epidermis and the deeper dermis/hypodermis.

When we receive a cut that reaches deep into the lower dermis/hypodermis layer, a large amount of connective tissue sometimes “fills the gap” that has been created. This replaces the normal layers of epidermis that would normally be created by the stratum basale layers. This connective tissue continues to grow and produce new layers of cells much like the stratum basale. However, as these cells reach the outer layers of our skin, they do not appear the same as the surrounding tissue.

Another common problem with our skin can be found in the presence of **blisters**.

Blisters

The two layers of our skin are connected together by a connective tissue known as the basement membrane. This is a seamless connection much like connecting two pieces of paper together with glue. But, as you may have experienced before, the act of gluing two pieces of paper together can be tricky because of air pockets that sometimes occur during the connection. These “air pockets” are what occur during the formation of a blister. Damage to the epidermis either by burning or friction (as in the continual rubbing of your shins against a new pair of shoes) can cause the epidermis to separate from the dermis/hypodermis at the basement membrane. Much like the air bubbles which form under the glued papers, the opened space between the layers of skin quickly fill with fluid from the damaged area as your body attempts to fix this separation.

Since we have mentioned burns, this may be a good time to identify the different types of burns and how they relate to the structure of our skin.

Burns

The burning of our skin is caused by exposure to excessive heat and can be placed into three different categories:

First-degree burns

These are burns which damage only the epidermis. They are typically red and painful, but not swollen and blistering. Sunburns are a good example of first-degree burns.

Second-degree burns

These are burns which damage the epidermis and the upper region of the dermis/hypodermis. Much like first-degree burns, these are red and painful as well. However, blisters typically form with second-degree burns.

Third-degree burns

Third-degree burns are severely painful. These burns may turn the skin white or charred in appearance. Heat from these burns destroys all layers of the skin, including blood vessels and nerve endings. Unlike with first- and second-degree burns, skin damaged by third-degree burns does not regenerate. Without the protective barrier of the skin, bacteria and viruses can easily enter the body; however, the largest threat is that of dehydration as the body cannot prevent water from evaporating from the body.

Let's move deeper into the body and look at what can affect our bones.

You have learned that our bones are actually living tissue and not simply hardened deposits of minerals that help to move our bodies. Our bones receive just as much exercise as our muscles when we use them regularly. In fact, our bones increase in size and strength when they go through different stresses such as those found during exercise.

It is a known fact that our bone tissue quickly breaks down when it is not being used. Some estimates state that bones which do not receive any form of exercise can lose up to a third of their mass after a few weeks! So don't spend all your time learning about anatomy and physiology... get out there and move!

Back in Chapter 4, you discovered that the growth of our bones involves a delicate balance between bone-developing cells (osteoblasts) and the bone-destroying cells (osteoclasts). The rate of development must equal that of its destruction or a problem will soon occur - especially if the rate of destruction is faster than that of development. This is the primary issue involved with a condition known as osteoporosis.

Osteoporosis

If the rate in which the osteoclasts destroy your bones is faster than the osteoblasts can grow new tissue, a bone can become very thin and be easily broken. **Osteoporosis** is more severe in women as their bones are normally smaller and thinner than those of males. Additionally, the chemical known as **estrogen** helps to maintain bone mass, so the loss of estrogen as a woman ages contributes to more severe osteoporosis.

Bone tissues within the spine may also become damaged if they become abnormally curved in a disorder called **scoliosis**.



Scoliosis

Scoliosis is the most common abnormal curvature of the spine and causes lateral (side) bending of the backbone. This curvature occurs either in the thoracic region, the lumbar region, or both of these regions. At this time, there is no known cause for most cases of scoliosis but it can be treated with specific braces on the back and with surgery.

The last condition we will look at occurs within the synovial joints of our skeletal system and is known as **arthritis**.

Arthritis

The name arthritis actually describes a group of disorders which affect synovial joints. Although there are many different causes for arthritis, they all involve damage to the cartilage which exists between the bones of synovial joints. One type of arthritis (known as **osteoarthritis**) commonly affects our larger, well-worn joints such as the hips and knees. Referred to as "wear and tear" arthritis, this disorder tends to affect us as we grow older and is the result of our everyday activities.

Another type of arthritis, **rheumatoid arthritis**, is caused by the inflammation of tissues within the synovial joints. Unlike osteoarthritis, this type usually affects the smaller joints first, such as those in the fingers, hands, and feet. This painful disorder can lead to the complete loss of functioning in the joint.

Let's see what is going on with our muscles now...

Instead of focusing our time on any of the numerous muscular disorders, I believe we should look at problems which occur on a daily basis to nearly all of us. First of all, let's spend a little time on the topic of muscle fatigue.

Muscle cells are very efficient at breaking down sugar into a chemical known as **ATP (adenosine triphosphate)** which is the main source of chemical energy needed for muscle fibers to contract. Typically, oxygen is present during the conversion of sugar to ATP (**aerobic respiration**); however, when oxygen is limited (**anaerobic respiration**) such as during a period of intense physical activity when oxygen is being used extensively, a waste product is created (**lactic acid**), which interferes with the process of muscle contraction and causes your muscles to become fatigued.

A "pulled muscle" is different from muscle fatigue. With pulled muscles, the muscle fibers have been stretched too far which causes them to tear apart. If an area of your body looks like it is bruised and/or swollen and you are in a good deal of pain a day after the activity, you likely have a pulled muscle.

What about muscle cramps?

You learned in Chapter 6 that all skeletal muscles move in pairs - because skeletal muscles can only pull! Therefore, when you are moving an object, your muscles first contract then stretch back when another muscle pulls it from an opposite direction. However, sometimes a muscle contracts with such force it stays contracted and no other muscle acts to stretch it back into place. This is a **muscle cramp**. The inability of muscles to stretch the muscle fibers back into place can be caused by a number of minor chemical or nerve cell problems. These problems occur when our muscles are fatigued, cold, or depleted of vital minerals needed for our nerve cells to function.

Muscle spasms are another frequent problem one may encounter during exercise. A muscle spasm is a strong, painful, and consistent involuntary contraction. Remember, an involuntary action is one that simply occurs without our will. A "charley horse" is a common muscle spasm in the leg that occurs when our muscles are overworked. When this happens, the muscle in our leg feels painfully tight and requires rest and time for it to end its contraction.

What happens to our muscles as we get older?

As we get older our muscle fibers tend to get smaller and lose their ability to pull with as much force as when we are young. This causes our muscles to become less elastic and causes exercise to become more strenuous and recovery to become more difficult.

Since there is no time machine or fountain of youth, how do we combat these problems?

Keep moving, stay active, and continue to exercise throughout your life!



Match the following vocabulary terms with their correct definition:

aerobic respiration
anaerobic respiration
arthritis
ATP (adenosine triphosphate)
blisters
estrogen

first-degree burns
inflammation
lactic acid
muscle cramp
muscle spasms
osteoarthritis
osteoporosis

pathogens
regeneration
rheumatoid arthritis
scars
scoliosis
second-degree burns
third-degree burns

- 1) _____ a group of disorders which affect synovial joints
- 2) _____ a large amount of connective tissue that replaces cut layers of epidermis resulting from a cut into the lower dermis/hypodermis layer
- 3) _____ a strong and painful involuntary contraction of muscles
- 4) _____ a type of arthritis caused by the inflammation of tissues within the synovial joints
- 5) _____ a type of arthritis commonly affects the larger, well-worn joints such as the hips and knees
- 6) _____ burns which damage only the epidermis
- 7) _____ burns which damage the epidermis and the upper region of the dermis
- 8) _____ chemical which helps to maintain bone mass and regulates the organs and tissues within the female reproductive system
- 9) _____ compound created by cells which acts as the main chemical fuel for all bodily processes
- 10) _____ condition in which bones become abnormally thin and brittle; caused by the excessive activity of osteoclasts

- 11) _____ conversion of sugar to ATP at times when oxygen is in abundance
- 12) _____ conversion of sugar to ATP at times when oxygen is limited
- 13) _____ disorder causing abnormal curvature of the spine and lateral (side) bending of the backbone
- 14) _____ first stage of tissue repair; identified by swelling, redness, excessive warmth, and pain in the area that contains the damaged tissues
- 15) _____ fluid-filled pocket between the epidermis and the dermis/hypodermis; caused by burning or friction
- 16) _____ harmful agents that invade the body
- 17) _____ heat from these burns destroys all layers of the skin, including blood vessels and nerve endings
- 18) _____ produced by muscle fibers during exercise which interfere with the ability of calcium ions to produce muscle contraction
- 19) _____ second stage of tissue repair in which the body attempts to restore homeostasis by replacing/repairing damaged tissues back to their normal functions
- 20) _____ situation in which a muscle contracts with such force it stays contracted and no other muscle acts to stretch it back into place

Choose the correct answer from the following questions:

1. **Anaerobic respiration occurs without the presence of:**

- A) glucose
- B) oxygen
- C) lactic acid
- D) ATP
- E) carbon dioxide

2. **What is the first threat to life from a massive third-degree burn:**

- A) blood loss
- B) infection
- C) dehydration
- D) unbearable pain

3. **True or False:** Joe just burned his hand on a hot pot. A blister forms and the burn is painful. Joe's burn would best be described as a third-degree burn.

4. **True or False:** In first-degree burns, only the epidermis is damaged.

5. **True or False:** Lactic acid results from aerobic respiration.

6. **True or False:** A muscle spasm results when the muscle is involuntarily contracted and fails to immediately relax.

Application Question:

Imagine the following experiment was run in a typical classroom. The normal rate of respiration for a group of resting students was determined. In Experiment A, students ran in place for 30 seconds and then immediately sat down and relaxed, where the rate of respiration was again determined. The same procedure was run for students in Experiment B; however, these students held their breath while running in place. What differences in the rate of respiration would you expect for the two different experiments? Defend your answer.