The practice of the healing arts (including Wilderness First Responder) does not lend itself well to a cook book approach. There are endless variations in the severity and manifestations of injuries and illnesses, as well as individual differences in the way people respond. Add to this the variables of weather, terrain, modes of communication and transportation and you can see why a "one size fits all" answer to dilemmas you are likely to face in a wilderness setting is left wanting. The specific course of treatment will be tempered by the ever-changing conditions encountered in the wilderness.

Wilderness First Responder training is a guide to making sound decisions under trying circumstances. To be able to do so, one must have a basic understanding of the underlying principles that support various courses of action. When it comes to treatment of persons who are suffering the ill effects of injury or illness, the underlying principles are based upon knowledge of anatomy and physiology. The former describes the structure of an organ system while the latter explains its function. The following is a brief and simplified description of the anatomy and physiology of certain organ systems we will encounter in the course.

Eye

1. The eye is a globe filled with jelly-like fluid
2. The globe is divided into two chambers by the **iris**
3. The **pupil** is a hole in the iris that allows light to enter; the pupil can change size
4. The visible part of the eye is covered by thin tissue called the **conjunctiva**
5. The pupil is covered by a specialized part of the conjunctiva called the **cornea**

Mouth and Throat

1. The mouth and throat are part of two systems:
    a. Digestive system
    b. Respiratory system
2. The upper airway contains **soft tissues** such as the tongue
3. When completely relaxed, the soft tissues can obstruct the upper airway, preventing delivery of air to the lungs

Brain

1. The skull is a rigid, enclosed box containing:
    a. Brain matter
    b. Blood (in blood vessels)
    c. Clear fluid called **cerebro-spinal fluid (CSF)**
2. The pressure inside the skull is called **intra-cranial pressure (ICP)**
    a. Any increase in volume inside the skull causes an increase in ICP
    b. The body can compensate for small changes in pressure by squeezing out CSF and venous blood.
    c. Further increases in volume cause an increase in ICP
    d. Elevated ICP interferes with normal brain function, leading to **coma** (unconsciousness)
    e. Deepening levels of coma are measured by the **Glasgow Coma Scale (GCS)**
    f. When ICP is higher than blood pressure, blood flow to the brain stops
3. Increases in ICP can be caused by brain swelling or by collections of blood outside of blood vessels called **hematomas**
    a. Both swelling and hematomas cause coma

b. Hematomas can also cause "focal signs" by applying increased pressure on nearby nerves
c. Common "focal signs" are:
    i. Unequal pupils
    ii. Weakness on one side of the body

Spine

1. The spinal column is made up of 33 bones called vertebrae, distributed as follows:

Cervical spine	Neck	7	C-1 thru C-7
Thoracic spine	Chest	12	T-1 thru T-12
Lumbar spine	Lower back	5	L-1 thru L-5
Sacrum	Pelvis	5	Fused
Coccyx	Tailbone	4	Fused

2. Each of the cervical, thoracic and lumbar vertebrae is composed of a bony arch attached to a cylindrical body.
3. The vertebral bodies are separated from one another by a compressible **vertebral disk** that acts as a shock absorber.
4. The main bundle of nerves (called the **spinal cord**) coming down from the brain passes through each vertebral arch.
5. Throughout its course down the spine, nerves come off of the spinal cord to give feeling and movement to different parts of the body.
6. Any interruption in nerve function will cause decreased sensation and/or weakness of the part of the body served by the injured nerve.
7. Common levels of decreased sensation/function related to injuries at specific vertebrae:

C-4	paralyzed diaphragm; ineffective breathing
T-4	numbness below nipples
T-10	numbness below belly button

Respiratory system

1. Atmospheric air reaches the lungs through airways that diminish in size and branch until they reach microscopic dead end sacs called **alveoli**.
2. Breathing is involuntary (we don't have to think about it) and controlled by a breathing center deep in our brain.
3. Breathing depends on an effective bellows action produced by the muscles of our chest wall and a large, flat muscle that separates our chest from our abdomen (**diaphragm**).
4. Gas exchange occurs at the interface of the alveoli and microscopic blood vessels called **capillaries**.
5. Exchange of gases at the alveolar-capillary membrane goes both ways (oxygen enters, carbon dioxide leaves).

Cardiovascular system

1. The heart is basically two pumps connected in series:
    a. The right heart receives unoxygenated blood and pumps it to the lungs.
    b. The left heart receives oxygenated blood from the lungs and pumps it to the rest of the body.
2. Rhythmic beating of the heart is in response to electrical stimulation that originates in specialized heart tissue. This intermittent pumping action is felt in the arteries as a **pulse**.
3. Blood is carried in blood vessels that diminish in size and branch to form **capillaries**.
    a. Blood flowing away from the heart is carried in **arteries**
    b. Blood flowing toward the heart is carried in **veins**
4. A series of valves in the cardiovascular system maintain flow in one direction only.
5. If blood flow to any tissue is inadequate, it causes **ischemia**; if blood flow is completely interrupted, it will cause **gangrene** (death of the tissue) within several hours.

Blood

1. Blood is a mixture of cells suspended in liquid.
2. The liquid portion is called **plasma** or **serum**.
3. The cellular portion is made up of many different types of cells:
    a. Red blood cells (RBC's) have **hemoglobin** that carries oxygen
    b. White blood cells (WBC's) help fight infection
    c. **Platelets** help blood to clot

Abdomen

1. The abdomen contains solid organs (eg. Liver, spleen,) that easily bleed when injured.
2. The abdomen also contains hollow organs, most of which help digest and absorb food.
    a. Stomach
    b. Small intestine
    c. Gall bladder
    d. Colon
3. The entire inside of the abdomen is enveloped in a thin, clear tissue (like Saran wrap) known as the **peritoneum**.
4. Most hollow organs contain bacteria; if the bacteria escape (eg. through a perforation in a hollow organ), a serious, life-threatening infection called **peritonitis** develops.
5. There is a solid space located behind the peritoneum (**retroperitoneal space**) where organs like the kidneys and pancreas reside.

Pelvis

1. The **pelvis** is a bony ring surrounding both abdominal and retroperitoneal organs.
    a. Abdominal
        i. Rectum (end of the colon)
        ii. Urinary bladder
        iii. Female genitalia (uterus, ovaries)
    b. Retroperitoneal
        i. **Ureters** (hollow tubes carrying urine from the kidneys to the bladder)
        ii. Many large blood vessels

Musculo-skeletal system

1. The skeletal system contains over 200 bones; sufficient force applied to these **bones** can cause them to **fracture**.
2. Blood vessels and nerves tend to run along bones; when bones are fractured it can cause injury to the blood vessels and nerves.
3. Long bones are joined by a series of articulations called **joints**; sufficient force applied to joints can cause a **dislocation**.
4. Bones and joints are sterile (have no bacteria); any fracture or dislocation that is open to the outside environment, however briefly, can result in infection.
5. Joints are held together by tough tissue called **ligaments** that help determine the direction of movement allowed by the joint. Sufficient force applied to ligaments can cause **sprains** (stretching); if the force is great enough, the ligament will tear.
6. The ends of bones, where joints are formed, are covered by a thick, smooth tissue called **cartilage** that acts as a shock absorber and allows frictionless motion in the joint.
7. Muscles apply forces across joints to cause motion. In order to work properly, muscles need to have input from nerves. Muscles are covered by tough, white tissue called **fascia**.
8. Injured muscles swell. This causes increased pressure in the fascial compartment containing the muscles, known as **compartment syndrome**. If untreated, this can irreversibly damage the nerves, blood vessels and muscles in that compartment.
9. In certain areas where space is limited (eg. hands and feet), muscles exert their force on bones through cable-like structures called **tendons**. Tendons can be cut by penetrating injuries and can rupture when blunt force is applied.

Skin

1. Skin has the largest surface area of any organ in the body; it is composed of 2 layers:
    a. **Epidermis** - outer layer that dies and is replaced monthly
    b. **Dermis** - thicker inner layer that cannot regenerate itself
2. Beneath the dermis is fat which has three main functions:
    a. Gives shape to our bodies
    b. Provides insulation
    c. Stores energy
3. The skin is a living organ with two critical functions:
    a. Controls how much fluid leaves the body
    b. Prevents bacteria and other microbes from entering the body
    c. Large surface area helps to control body's temperature

Shock

The most common life-threatening condition you will encounter in a wilderness setting is shock. In medical terms, **shock is defined as inadequate delivery of oxygen to the body's tissues**. The tissue that is most sensitive to lack of oxygen is the brain. There are many systems that need to work together to deliver oxygen to the tissue, but the most important are:

1. Respiratory system
    a. Airways to get atmospheric oxygen to the lungs
    b. Lungs to absorb atmospheric oxygen into the body
2. Circulatory system
    a. Blood to carry and deliver oxygen
    b. Heart to pump blood
    c. Blood Vessels to carry blood

Shock can be due to a number of causes, but the most common by far following a significant injury (trauma) is hemorrhagic shock due to blood loss. When blood is lost, the body compensates in predictable ways.

1. The heart pumps faster
2. The blood vessels squeeze down to preserve blood flow to the brain and heart
    a. Skin becomes cold and clammy
    b. Kidneys produce less urine
    c. Initially, blood pressure is maintained
    d. If untreated, blood pressure drops, blood flow to brain decreases causing changes in thinking

Directional References