**What We Know**

* Many products of bodily metabolism are waste products that the body does not need or cannot use.
* The three organ systems that indirectly help to remove toxins from the body are:
  + Respiratory System - removes toxic gases and volatile chemicals from the body
  + Integumentary System - can remove toxins through sweating
  + Digestive System - eliminates toxins taken in by eating or drinking through feces
* The two organs with the biggest roles in detoxification are the liver and kidneys
* Liver
  + The liver is unique because blood flows into the organ from the gut.
  + The two steps that the liver takes to detoxification are
    - When Kupffer cells engulf/eat sludge trapped in the small spaces between cells
    - When Kupffer cells add materials to a chemical to make it non-harmful, a process called conjugation
* Kidneys
  + Blood goes from the liver to the heart and then to the kidneys.
  + Kidneys regulate the balance of water, minerals, and salts in the body
  + About 150 liters of blood are pumped through the kidney every day.
  + Blood flows into the kidney through the renal artery and leaves through the renal vein.
  + Each filtering unit in the kidney is called a nephron.
  + The glomerulus is a cluster of small blood vessels that allow small molecules of waste and fluid pass through them into the tubule.
  + Water, minerals, and nutrients are reabsorbed from the tubule into the blood.
  + Urine travels from the kidney through the ureter to the bladder where it is stored. Then when urine is ready to leave the body, it exits through the urethra.

**How We Know**

* Kidney Function
  + Medical technicians examine urine through a procedure called urinalysis to look for any abnormalities. Diseases that can be detected by this method include:
    - Diabetes
    - Kidney stones
    - Chronic urinary tract infections
  + The three ways we analyze urine are:
    - Unmagnified/macroscopic: check for amount, color, clarity
    - Chemical analysis: check for acidity, density, amount of protein, glucose, ketones, nitrites, and white blood cells.
    - Magnified/microscopic: check for crystals, squamous cells, bacteria, and other large objects
  + A small amount of urine could indicate that the kidneys (are/are not) filtering blood well.
  + The presence of white blood cells in urine could indicate infection of the kidneys, bladder, or other parts of the urinary tract.
* Liver Function
  + We can tell a lot about the liver by observing it:
    - Large veins come into the liver from the gut
    - Blood flows past single rows of liver cells
    - The path of flow exposes blood to many phagocytic cells
  + We can also tell a lot about the liver by seeing how the chemical contents of blood change between entering and exiting the liver. The liver:
    - Makes urea, a protein waste product
    - Makes bile, which is released to from the gallbladder and makes fat easier to digest in the intestines
    - Removes low density lipids and adds high density lipids to blood, protecting against hardening of the arteries
    - Converts and detoxifies many drugs and toxins
  + A symptom of poor liver function is yellowing of the skin and eyes, called jaundice, as well as prolonged bleeding, and swelling and hardening of the liver.
  + The most common causes of liver damage are alcohol abuse and viral hepatitis

**Common Hazards**

* Hepatitis is irritation/inflammation of the liver and can end up resulting in the death of liver cells and eventual replacement with scar tissue (cirrhosis).
  + Causes of hepatitis include
    - Excessive drug or alcohol consumption
    - Viruses
    - Our own immune system
  + There are six different hepatitis viruses.
    - Hepatitis A - (does/does not) have a vaccine. Spread by feces of infected person.
    - Hepatitis B - (does/does not) have a vaccine. Spread by blood and bodily fluids from infected person.
    - Hepatitis C - (does/does not) have a vaccine. Spread by blood and bodily fluids from infected person.
    - Hepatitis D - (does/does not) have a vaccine. Spread by blood and bodily fluids from infected person. Only occurs in presence of Hepatitis B infection
    - Hepatitis E - (does/does not) have a vaccine. Spread by feces of infected person.
* Heavy metals like cadmium, mercury, lead, and chromium are toxic to the kidneys and cause damage to the liver.
  + Lead
    - List 4 sources of lead exposure:
      * Old paint
      * Old pipes
      * Contaminated water
      * Batteries
      * Industrial processes
      * Leaded gasoline
      * Cosmetics
      * Toys
      * Containers made of metal
    - Children are most susceptible to the effects of lead.
  + Mercury
    - The kidneys concentrate mercury
    - Mercury bioaccumulates in food chains (it accumulates in organisms that eat other organisms that contain mercury). For example, eating large quantities of contaminated fish or shellfish can lead to mercury toxicity.
  + Cadmium
    - Cadmium damages kidney tubules (also causes anemia and bone and mineral loss)
    - Cadmium reacts with proteins and accumulates in the kidneys.
  + Chromium
    - Chromium-3 is an essential dietary requirement for humans, and is found in vegetables, fruits, meats, grains, and yeast
    - Chromium-6 is toxic and can be found in the environment but is also produced by industrial processes.
    - Chromium is reabsorbed by tubule cells and becomes very concentrated. It can also become corrosive and cause kidney failure.
* Free Radicals
  + Name 3 external sources of free radicals
    - Pollution
    - Cigarette smoke
    - X-rays
    - Ozone
    - Industrial chemicals
    - Medication
  + Free radicals can be both toxic and beneficial
  + At excessive levels, free radicals can damage cell parts like the cell membrane and DNA.