1. What are the main functions of the human excretory system? (Think: Homeostasis)

    - Osmoregulation (salt balance and water gain/loss)
    - Regulates blood pressure
    - Regulates pH
    - Excretion (removal of soluble nitrogenous waste)

2. Can you describe the difference between osmoconformers and osmoregulators?

    - Osmoconformers – animals that are isoosmotic with their environments (no water gain/loss)
        - Includes: marine invertebrates
    - Osmoregulators – animals that control their internal osmolarity independent of the external environment
        - Includes: marine bony fish (hypoosmotic), Sharks (slightly hyperosmotic), freshwater fish (hyperosmotic), and terrestrial animals (hyperosmotic)
            - Hyperosmotic animals (must discharge excess water)
            - Hypoosmotic animals (must take in water to offset osmotic loss

3. Can you list the three forms of animal nitrogenous wastes in order of toxicity, water requirement (for excretion), and energy requirement (to synthesize)?

    - Toxicity: Ammonia > Urea > Uric acid
    - Water requirement: Ammonia > Urea > Uric acid
    - Energy requirement: Uric acid > Urea > Ammonia

4. Can you list and describe the steps of the general excretory process found in urine-forming animals?

    - Steps: Filtration → Reabsorption → Secretion → Excretion
        - Filtration: Body fluid contacts transport epithelium & hydrostatic pressure (or blood pressure) drives filtration; water and small solutes filter out and form the filtrate; Cells, proteins, and larger molecules remain in the body fluid
        - Reabsorption: Good stuff (glucose, certain salts, vitamins, hormones, and amino acids)is reabsorbed by active transport
        - Secretion: Bad stuff (toxins & excess ions) is added to the filtrate
        - Excretion: The altered filtrate (urine) leaves the body

5. Do the following tubular systems function in osmoregulation, excretion, or both?

    a. Protonephridia (freshwater planaria): Osmoregulation only (removes excess water)

    b. Protonephridia (parasitic flatworms): Excretion only

    c. Metanephridia (earthworms): Both (removes excess water)

    d. Malpighian tubules (insects): Both (conserves water)

    e. Kidneys (terrestrial animals): Both (usually conserves water)

The Nephron

6. How does blood filtration occur in the Bowman's capsule?

- Blood pressure forces fluid from the blood (in the glomerulus) to flow into the lumen of Bowman's capsule
- The porous capillaries and specialized cells of the capsule are permeable to water and small solutes (but not to blood cells or large molecules such as plasma proteins)
- Bowman's capsule filtrate contains: salts, glucose, amino acids, vitamins, nitrogenous wastes, and other small molecules
- Filtration of these small molecules is nonselective, so the filtrate mixture mirrors the concentrations of these substances in the blood

7. Can you describe the pathway of the filtrate?

- Pathway: Bowman's capsule → proximal tubule → loop of Henle → distal tubule → collecting duct → renal pelvis
    - Proximal tubule – conveys and helps refine filtrate
    - Loop of Henle – the tubule b/w the proximal & distal tubules of the kidney that functions in water & salt reabsorption; has a descending and ascending limb
    - Distal tubule – portion of a nephron that helps refine filtrate and empties it into a collecting duct
    - Collecting duct – location where processed filtrate (urine) is collected from the renal tubules
    - Renal pelvis – funnel-shaped chamber that receives processed filtrate (urine) from the collecting ducts and is drained by the ureter

8. Why is the transport epithelium important in urine formation?

- Transport epithelium – lines the nephron & collecting duct; processes the filtrate and forms the urine
- Most important task of the transport epithelium is the reabsorption of solutes & water (99% of water and nearly all of the sugars, amino acids, vitamins, and other organic nutrients are reabsorbed into the blood)

9. Can you list and describe the blood vessels associated with the nephron?

- Renal artery (enters kidney) & Renal vein (exits kidney)
- Afferent arteriole (enters nephron) & Efferent arteriole (leaves nephron)
- Three sets of capillaries in each nephron:
    - Glomerulus (inside Bowman's capsule)
    - Peritubular capillaries (surround the proximal & distal tubules)
    - Vasa recta (serves loop of Henle) – vasa recta blood flow is opposite the flow of filtrate in the neighboring loop of Henle (ascending vasa recta is next to the descending loop of Henle and vice versa); both the tubules & capillaries are immersed in interstitial fluid – substances diffuse b/w the plasma (w/in the capillaries) and the filtrate (w/in nephron tubule); the loop of Henle & vasa recta do not directly exchange materials, but they do function together as part of a countercurrent system that enhances nephron efficiency

10. Which hormones regulate homeostasis in the kidney?

- ADH – comes from posterior pituitary; triggered by high blood osmolarity & functions to promote water retention in kidneys; acts on distal tubules & collecting ducts
- RAAS (renin, angiotensin II) comes from JGA; triggered by low blood pressure or volume & functions to increase blood pressure and volume; angiotensin II constricts arterioles & stimulates adrenal gland to release aldosterone
- Aldosterone – comes from adrenal gland; makes the distal tubules reabsorb water/sodium (increases blood pressure & volume)
- ANP – opposite effects of ADH & RAAS; comes from heart atria in response to high blood pressure