Functions of the Kidneys

- 1. Regulate blood volume
- Kidneys help maintain <u>blood pH</u> normal pH is about <u>7.4</u> we need this so cell functioning works best

Thinking question: What does our body do to make sure our pH blood levels stay around 7.4?

Via acid-base buffer systems, the respiratory centre and the kidneys!

Buffer: a chemical that takes up a hydrogen ion or a hydroxide ion when they are in excess

- The main buffer system in blood is the combination of **<u>carbonic</u>** acid and bicarbonate ions:
 - $H^+ + HCO_3^- \rightarrow H_2CO_3$ (when hydrogen ions are added)
 - $OH^- + H_2CO_3 \rightarrow HCO_3^- + H_2O$ (when hydroxide ions are added)

In the kidneys: Nephrons vary the amount of $\underline{H^+}$ and $\underline{NH_3}$ that they excrete and the amount of HCO_3^- and Na^+ they <u>reabsorb</u> – helps keep pH within normal limits

If blood is <u>acidic</u>: hydrogen ions are excreted, ammonia is excreted, and bicarbonate ions are reabsorbed

If the blood is **<u>basic</u>**: hydrogen ions are not excreted, bicarbonate ions are not reabsorbed

Practice:

1. Describe the process if the amount of H⁺ ions in the kidneys increase, resulting in increased pH levels.

Hydrogen is excreted from the tubes of the nephron and bicarbonate ions are reabsorbed

2. If the pH in our blood in measured to be 7.2, what will likely be the body's response in bringing the pH back to 7.4?

Hydrogen is not excreted by the nephron and bicarbonate ions are not reabsorbed

Disorders of the Urinary System

Kidney functions are vital to homeostasis – problems can be life-threatening

Cystitis: infection of bladder after bacteria get into urethra

Infections can be detected with urinalysis - look for blood cells and proteins in urine

➔ Normal urine never has blood protein or blood cells in it; it should also not contain more than trace amounts of glucose

Pyelonephritis: infection in the kidneys and usually result from infections in the bladder that spread via the ureters

- Kidney infections are usually curable with antibiotics if diagnosed in time

Kidney stones: hard granules that form in the renal pelvis; composed of substances such as calcium, uric acid, protein, or phosphate

- Caused by too much protein in diet, infections or pH imbalance
- Can be VERY painful if large enough (just ask my dad)
- May need to break stone with powerful ultrasounds waves

If nephrons become destroyed (2/3 or greater), waste accumulate in the blood (=uremia)

If water and salts retained, fluid would accumulate in the body tissues and there would be ionic imbalances (=**edema**); can lead to problems including loss of consciousness and heart failure

Kidney replacements – must be used in case of renal failure

What are the options? 1) transplant or 2) artificial kidney

- 1. Kidney transplant one kidney is adequate for normal functioning, so it is possible to donate one kidney and live.
 - requires living or recently deceased donor
- 2. Dialysis diffusion of dissolved molecules through a semipermeable membrane that only allows small molecules to pass through

There are two basic forms a) **kidney machine** b) **continuous ambulatory peritoneal** (= abdominal) dialysis <u>CAPD</u>

Both utilise **semi-permeable membrane** that allows molecules to diffuse across it according to **concentration gradients** - are manipulated so that **wastes can be removed**, **nutrients/ions added**, **pH adjusted**.

- a) Kidney machine when no available donors, a machine is used to filter the patients blood.
 - 1. Blood passes across semi-permeable membrane which has balanced salt (dialysis) solution

- 2. Wastes exit blood into solution because of pre-established concentration gradient
- 3. Can extract substances from blood, or add substances
- 4. Works **faster** than real kidneys therefore only needs to be done twice a week (6 hour session)
- b) CAPD (Continuous Ambulatory Peritoneal Dialysis allows dialysis away from hospitals.
 - 1. Patient has tube permanently implanted into abdominal cavity
 - 2. Dialysate fluid introduced into abdominal cavity through plastic bag, which is rolled up after so student can move around.
 - 3. Wastes and water pass into fluid (4-8) hours.
 - 4. Bag lowered, fluid drains out.
 - 5. Process repeated with fresh fluid

Bladder stones: can form as a result of an infection or kidney stones that pass into the urinary bladder and become larger

- Painful, difficulty urinating, blood in urination and increased amount of urination
- Can be removed surgically or by blasting them apart with ultrasound waves

YOUR TURN!

Research a disorder or problem associated with the kidney and/or urinary system. You may work with a partner if you wish. Answer the following question related to the disorder you have researched.

- 1. What is the disorder/condition/problem/disease?
- 2. How is it caused? What is it caused by?
- 3. How is it treated? What are the options for treatment?
- 4. What part of the urinary system is involved?
- 5. What are the complications or long term effects associated with the disorder?
- 6. Include any relevant information, details, or statistics that would be valuable.
- 7. Include any diagrams or figures that would be helpful in your description.

Please write this as a paragraph, story, or illustration if you desire. This is a one –page short assignment, to be completed in class with your partner. Please answer each question as best as you can.