

# Certification Review Course

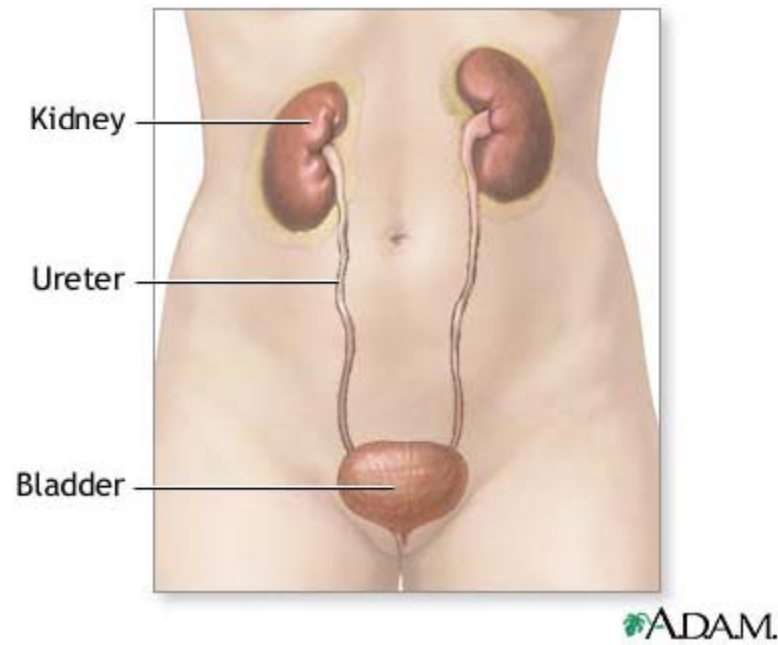


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# Objectives

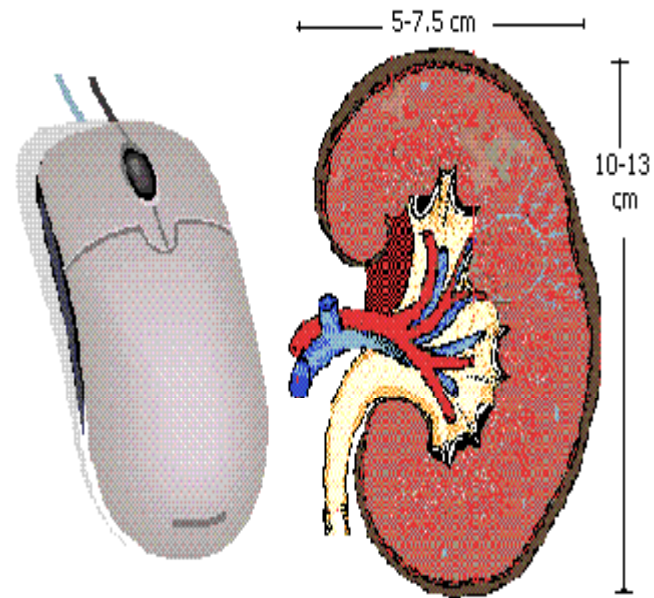
- Understand Basic Renal Anatomy & Physiology
- Review of Acute and Chronic Renal Failure
- Review of Treatment Modalities & Vascular Access
- Renal Diet & Fluid Restrictions

# Renal Anatomy



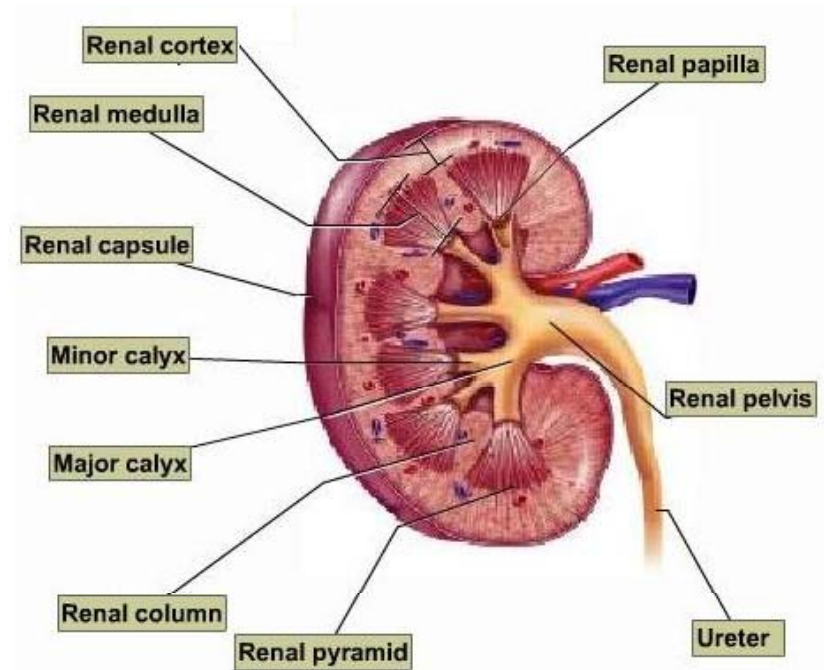
# The Kidney

- Bean-shaped organs
- 170 grams (size of a fist)
- 20% of Cardiac Output
  - 1 L/min of blood
  - 120 ml/min of plasma is filtered



# Renal Anatomy & Physiology

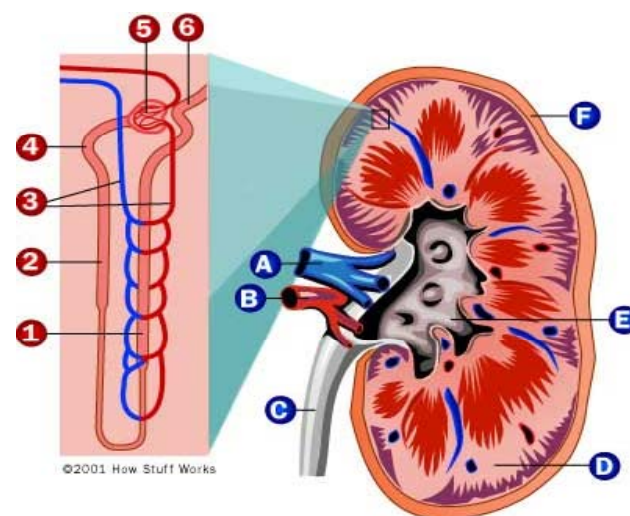
- Work 24 hours 7 days a week
- Maintain a constant balance of chemicals and fluid
- Most people have 2 kidneys



# Renal Anatomy & Physiology

## How Healthy Kidneys Work

- Blood with waste enters the Renal Artery
- Each kidney has over a million nephrons
- Filtration occurs in the Glomerulus
- Urine goes to Collecting duct to the Renal Pelvis
- Filtered blood flows through the Renal Vein & back to the body
- The Ureter is the vessel connecting the kidney to the bladder. Waste products leave the kidneys via the bladder. The waste is called urine.



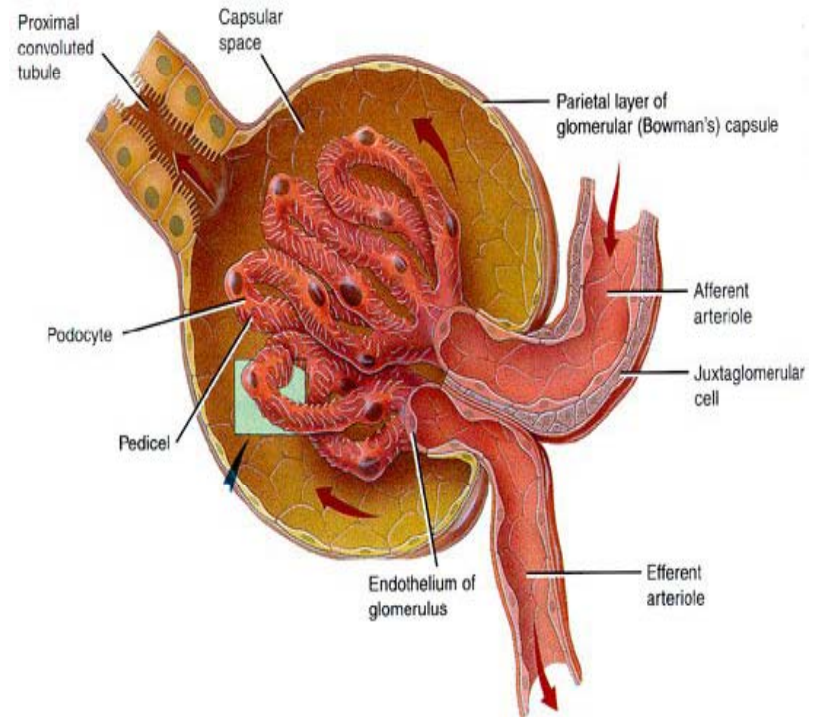
- |   |                       |
|---|-----------------------|
| <b>1</b> Ascending limb of loop of Henle                        | <b>A</b> Renal vein   |
| <b>2</b> Descending limb of loop of Henle                       | <b>B</b> Renal artery |
| <b>3</b> Peritubular capillaries                                | <b>C</b> Ureter       |
| <b>4</b> Proximal tubule  | <b>D</b> Medula       |
| <b>5</b> Glomerulus (Bowman's capsule + Glomerular capillaries) | <b>E</b> Pelvis       |
| <b>6</b> Distal tubule  | <b>F</b> Cortex       |

# The Nephron

- The working unit of the kidney
- Filters and cleans the blood, discards excess water and wastes
- Keeps the body in balance (Homeostasis)
- 1 million of them per kidney
- Made up of a Glomerulus and a tubule
- Nephrons empty into collecting ducts

# Glomerulus

- A tangled ball of capillaries held together by a membrane called the Bowman's capsule.
- The capillary walls are semipermeable membranes



# Glomerulus in Action

- Blood enters each glomerulus from an afferent (toward the organ) arteriole (small artery)
- Blood pressure forces water to filter out the blood-through tiny slits-into the urinary space of a glomerulus
- Small wastes pass through pores along with the water to form a liquid called Glomerular filtrate.
- Normal Glomerular Filtration Rate-120ml/min or 180 liters/day.
- *(If there is damage to the nephrons, larger substances, like protein, pass through)*

# Coffee Maker –vs- Glomerulus



# Physiology of Tubular System

- Glomerulus sends filtrate into a tubule
- Tubule has 4 parts:
  - Proximal Convoluted Tubule
  - Loop of Henle
  - Distal Convoluted Tubule
  - Collecting Tubule
- Chemicals and water the body needs are reabsorbed into the blood through the tubules, the rest gets emptied and then flows into the ureters to be excreted as urine.

# Question

- The functional unit of the kidney is the:
  - a. Medulla
  - b. Cortex
  - c. Calyx
  - d. Nephron

# Question

A nephron is made up of:

- a. A glomerulus and a tubule
- b. A nephron and a capsule
- c. The Loop of Henle and a capillary bed
- d. The Bladder and the ureter

# Functions of the Kidney

- A – Acid - Base Balance
- W – Water Removal
- E – Electrolyte Balance
- T – Toxin Removal
- B – Blood Pressure Control
- E – Erythropoietin Production
- D – Vitamin D Metabolism

# Acid-Base Balance

- The body is very sensitive to its pH level
- The kidneys maintain acid-base balance (homeostasis) by regulating the pH of the blood plasma.
- Dialysis helps to restore acid/base balance

# Fluid Removal

- Only about 1% of water contained in glomerular filtrate is excreted in urine; almost 99% is reabsorbed in the bloodstream
- Urine is excess body water with high levels of waste products.
- Dialysis removes some fluid on treatment days

# Water Compartments

- **Intracellular: “first space”**. Located within tissue and muscle cells (inside the cells). Makes up 2/3 of total body water.
- **Intravascular: blood inside the blood vessels.**
- **Extracellular or Interstitial: “second space”**. Is composed of water between cells and plasma.
- **Whole blood is in both the intracellular and extracellular compartment**
- **Transcellular: “third space”**. Makes up aprox 1-3% of body water. It exists in various compartments:
  - **Cerebrospinal**
  - **Pleural**
  - **Peritoneal**
  - **Gastrointestinal**

# Question

- Which of the following best describes the “intravascular” fluid compartment?
  - a. Fluid inside the cells
  - b. Blood inside the blood vessels
  - c. Fluid between cells
  - d. Fluids inside and between cells

# Electrolyte Balance

- Glucose, protein, and electrolytes that pass through the kidneys go back into blood or are metabolized (used).
- Sodium, Potassium, Chloride, Calcium, Magnesium are kept in balance.
- Dialysis helps to restore electrolyte balance.

# Removal of Wastes

- One of the main tasks of the kidney
  - Rid the body of waste and excess fluid
- Wastes comes from foods that are digested
- Wastes come from the breakdown of tissue due to normal muscle use
- Dialysis removes some waste on treatment days

# Blood Pressure Control

- Fluid and sodium control aid in blood pressure control
- In the Distal Tubule, water is absorbed with sodium
- Dialysis helps to control blood pressure by removing fluid and balancing sodium on treatment days

# Hormone Production

- The kidneys trigger the bone marrow to make red blood cells by producing Erythropoietin
- “Antidiuretic Hormone”- released by the pituitary gland to help control the blood pressure
- Dialysis can't make erythropoietin, but erythropoietin can be given.

# Vitamin D Metabolism

- Active Vitamin D or Calcitriol- controls Calcium and Phosphorus balance that helps with bone metabolism
- Dialysis cannot activate Vitamin D, but Vitamin D sterols can be given.
- Dialysis can change Ca levels by adjusting Ca in dialysate and some Phosphorus can be removed, but not as well as healthy kidneys

# Types of Renal Failure

- Acute Renal Failure
- Chronic Kidney Disease
- End Stage Renal Disease

# Acute Renal Failure

- Sudden loss of kidney function
- Causes:
  - Prerenal-interruption in blood flow
    - Severe Dehydration      Heart Disease
  - Intrarenal-injury to the kidneys
    - Trauma      Nephrotoxic Drugs
  - Postrenal-blockage causing urine back-up
    - Kidney Stones      Kinked ureter      Tumors
- Treatable
  - Lasts days, weeks, months

# Chronic Kidney Disease

- A slow, progressive loss of nephron functions over a period of months or years and defined as an abnormally low glomerular filtration rate.
- Usually determine by the creatinine level in blood serum.

# End Stage Renal Disease

- CKD that leads to severe illness and requires some form of renal replacement.

# How to Slow Kidney Disease Progression

- Blood Pressure Control
- Diet
- Blood sugar control in Diabetics
- Stop smoking
- Lower Cholesterol levels

# Stages of Chronic Kidney Disease

<b>Stage</b>	<b>GFR</b>	<b>Description</b>
1	>90	Kidney damage with normal GFR; no symptoms
2	60-89	Kidney damage with decreased GFR; Anemia
3	30-59	Moderate decrease in GFR; Fatigue, Anemia, Edema
4	15-29	Severe decrease in GFR; prepare pt for dialysis or transplant
5	<15	Kidney Failure; Begin dialysis

# Causes of Renal Failure

- Diabetes
  - Diabetic Nephropathy (Diabetic Kidney Disease)#1 Cause of CKD Stage 5 in the US
  - 1-2 main types of Diabetes cause most kidney disease
    - Type I –Pancreas can't make Insulin
    - Type II-The body can't make enough insulin or can't use what it makes (90% of pts)

# Causes of Renal Failure

- Hypertension
  - 2<sup>nd</sup> most common cause of CKD
  - Cause usually unknown
    - Stress                      being overweight                      smoking
    - High salt diet                      heavy use of alcohol
- Glomerular Disease
  - Glomerular Nephritis-inflammation of glomerulus
  - Glomerulosclerosis (narrow)-narrowing of glomeruli

# Question

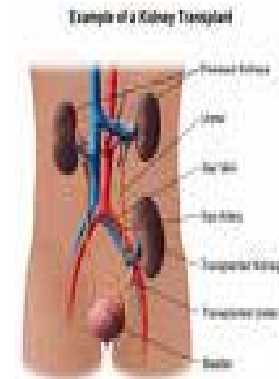
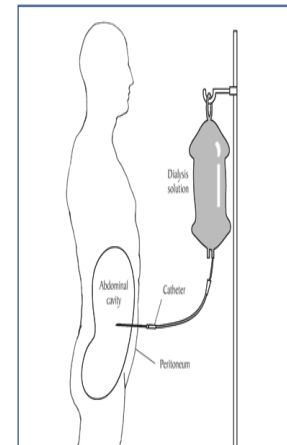
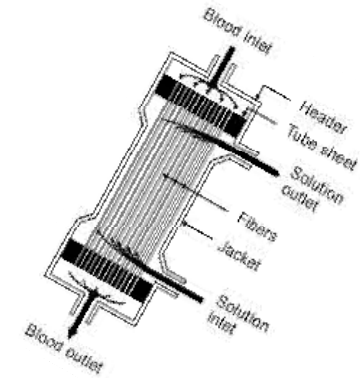
- The leading cause of chronic kidney disease for adults in the US?
  - a. Hypertension
  - b. Glomerulonephritis
  - c. Diabetes
  - d. Urinary Obstruction

# Causes of Renal Failure

- Polycystic Kidneys (PKD)
  - Genetic cysts (fluid filled)
- Other Causes
  - Birth defects, AIDS, Sickle Cell Disease, Use of street drugs, Cancer, Large Kidney Stones  
Lupus (immune system disease), Trauma

# Treatment Modalities

- Discuss the Treatment Options for Kidney Failure
  - Dialysis
  - Peritoneal Dialysis
  - Transplant
  - None



# Dialysis

- The process of cleaning the blood by removing waste and fluid build-up when the kidneys fail through a semi-permeable membrane.
- Both blood and dialysate are pumped through the dialyzer at the same time.
- Dialysis only replace 15% of kidney function.

# Dialysis

- A well-dialyzed patient has:
  - Good fluid balance
  - Normal Blood pressures
  - Anemia controlled
  - Slow rate of bone disease
  - Blood tests in target range

# Dialysis

- A well-dialyzed patient has:
  - More energy
  - Sleeps well
  - Has a good appetite
  - Has good coping skills

# Peritoneal Dialysis

- Uses the patients own peritoneal membrane as the filter
  - Membrane is inside the abdomen (Peritoneum)
- A plastic catheter is placed in the abdomen
- Minor surgery

# Benefits of Peritoneal

- Self-care Treatment
  - Can be done alone or with a partner
- Training usually takes 3-6 weeks
- Fits into the patients lifestyle
- Allows working patients to keep their jobs
- Fewer Diet and fluid limits

# Peritoneal

- Most common complication is Peritonitis
  - Inflammation of the Peritoneum
- How to prevent Peritonitis?
  - Follow the steps exactly as taught to you (the patient)
  - Good Handwashing
  - Wear Mask during exchanges

# Types of Peritoneal Dialysis

- CAPD (Continuous Ambulatory Peritoneal Dialysis)
  - Manual exchanges are done
- CCPD (Continuous Cycling Peritoneal Dialysis)
  - A machine (cyclor) is used to automatically perform exchanges during the night

# Kidney Transplant

- Places a healthy kidney from another person into your body.
  - The patient has to be healthy enough for surgery
  - The most effective therapy for End Stage Renal Disease

# Kidney Transplant

- 3 Transplant Options
  - Kidney from a blood relative (Living Related Donor)
  - Kidney from a non-blood relative (spouse, teacher friend (Living non-related donor)
  - A deceased donor kidney from a National Transplant List

# Kidney Transplant

- Why are patients tested?
  - Make sure that blood and tissue match
  - Make sure that the donor and the recipient can handle the procedure (physically and mentally)

# Common Complications of Transplantation

- Early complications
  - Surgical complications
  - Delayed or slow graft function
  - Lymphocele
- Acute rejection
  - The immune system sees the transplant as a foreign body and “attacks” it.

# Kidney Transplant

- Anti-rejection drugs are given-known as (immunosuppressant drugs)
  - Side effects
    - Weight gain
    - Hypertension
    - Increased chance of Infection
    - Cancer
- A special diet is followed, but not as limiting as for the “In-center Hemo” patients

# Vascular Access

- Allows for repeated access to a patient's blood.
- The “Achilles Heel of Dialysis”
- Three Types of Accesses:
  - Fistula
  - Graft
  - Catheters

# What is a Fistula?

- Surgical connection between an artery and a vein
- Best type of access, but not everyone is a candidate
- Encourage your patient to start exercising approximately 1 week after surgery

# Types of Fistulas

- Radiocephalic- Link between radial artery (wrist) and cephalic vein (elbow)
  - Most common
- Brachiacephalic- Brachial artery connected to the cephalic vein
- Transposed Basilic Vein- a deep vein brought closer to the surface of the skin and the vein is moved to the front of the upper arm

# Types of Fistulas



Radiocephalic Fistula



Brachiacephalic  
Fistula

# Fistula

- Advantages

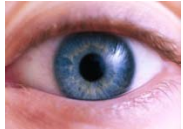
- Lasts longer
- Less chance of Infection

- Disadvantages

- Takes longer to mature (4-12 wks)
- Slow to develop
- Stenosis may develop

# Vascular Access

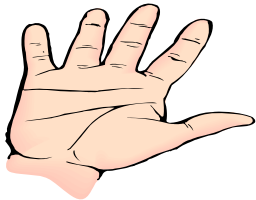
## Assess the Access each treatment



- Look for signs of infection, redness or drainage



- Listen for the bruit (low pitch sound)



- Feel for the thrill (purring or vibrations)

The Palm

# Learn these Words

- Steal Syndrome-not enough blood to the hands after access placement.
- Stenosis-(narrowing) Swollen access arm
- Bruit- swooshing noise; louder if stenosis is present
- Thrill- continuous vibration; not a strong pulse
- Aneurysm-ballooning or bulging of a blood vessel

# Cannulation Points

- Always wash the site before cannulating
- Keep needles at least 1 ½ inch from anastomosis
- Avoid curves, flat spots, aneurysms
- Always use a tourniquet
  - Even if the vessel appears large enough
    - Helps stabilize the vessel
    - Gives it a better feel
    - Helps to see the vessel better

# Needle Insertion

- Arterial needles can be antegrade or retrograde
- Venous needles should always be place antegrade (toward the blood flow/toward the patient)
- Bevel down-prevents coring

# Cannulation Techniques

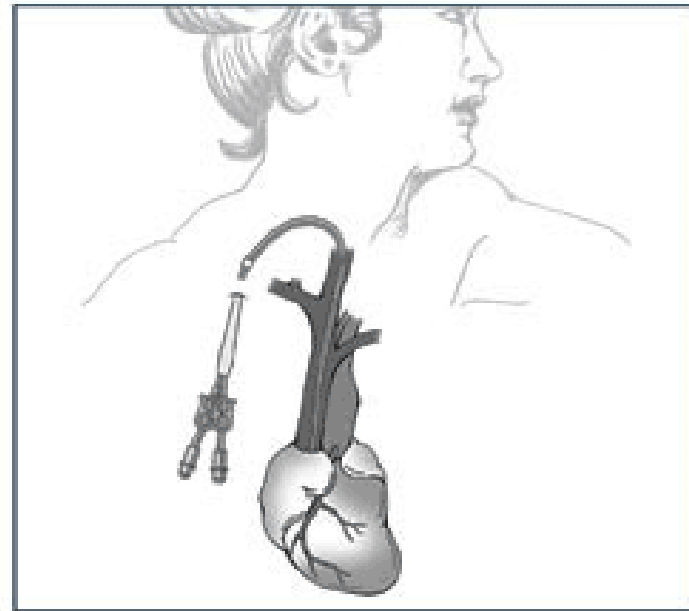
- Rope Ladder or Rotating-Each treatment you choose 2 new holes
  - Rotate sites to prevent aneurysm formation
- Button Hole Technique or Constant Site
  - For patients with low pain tolerance
  - For patients with limited access areas
  - Fewer missed insertions & infiltrations
  - Fewer infections

# Graft

- An artificial (synthetic) blood vessel used to connect an artery & vein
  - Advantages
    - Takes less time to mature
    - Larger areas to cannulate
    - Easier to cannulate
    - Used in
      - Diabetics
      - Older Patient
      - Patients with Poor Circulation
  - Disadvantages
    - More prone to infection
    - More prone to Thrombosis (clotting)
    - More likely to develop a stenosis

# Catheters

- Catheter- a subcutaneous port under the skin
- Reasons for Use
  - Acute Renal Failure
  - Peritonitis
  - Awaiting a Transplant
  - Refuses a permanent access



# Catheters

- Advantages

- Good for urgent use
- Can be hidden under clothing
- Pt able to move more freely
- No needles used

- Disadvantages

- Leads to infection
- Can cause inflammation, clotting, and stenosis
- Lower blood flows leading to poor adequacy

# Renal Diet & Fluid Restrictions

- Goal of the Renal diet
  - To maintain nutrition
  - Keep build up of wastes between treatments to a minimum
- Planned for every patient
  - Individualized
  - Can be changed based on patient needs

# Renal Diet

- Includes:
  - Protein-aids in growth and maintains body tissue, provides energy, keeps fluid balance
  - Sodium-found naturally in foods; can't be eliminated; attracts fluid in the body
  - Potassium-controls & transmits nerve impulses
  - Phosphorus-Major source from the Bones; helps with energy, absorption, metabolism of fats

# Fluid Restrictions

- When the kidneys fail
  - Little or no urine is produced
  - Excess fluid is retained
  - Fluid must be removed through dialysis
- Fluid weight varies between patient treatments

# Fluid Restrictions

- In-center hemo patients need fluid restriction
  - Limited to volume of the patients urine output + 1 liter (4 cups/day)
  - No urine output- patient is limited to 4 c/day
- Dry Weight-Post dialysis weight at which excess fluid has been removed and the patient is normotensive

# Patient Education

- Teach the effects of Protein
  - Too much = Elevated BUN or Effects Dialysis treatment time
  - Too little=Protein Malnutrition
- Teach the effects of Sodium
  - Too much leads to Dehydration
  - Too little caused by diarrhea or fluid overload
- Teach the effects of Potassium
  - Too much=Arrhythmias
  - Too little=weakness

# Patient Education

- Phosphorus
  - Sources
    - All protein foods (Meat, fish, poultry, eggs)
  - Avoid or limit these sources
    - Milk and milk products
    - Cheese
    - Dried beans
    - Chocolate
    - Cola
    - Nuts and seed
    - Whole grains

# Patient Education

- Encourage your patients to limit their fluids
- Anything that melts at room temperature is considered “Fluid”
- Never guess when you are talking to your patients about diet related issues-refer them to the Dietitian or any nutritional handouts that might be in your unit.

# Questions



**CRITICAL THINKING IS KEY!**