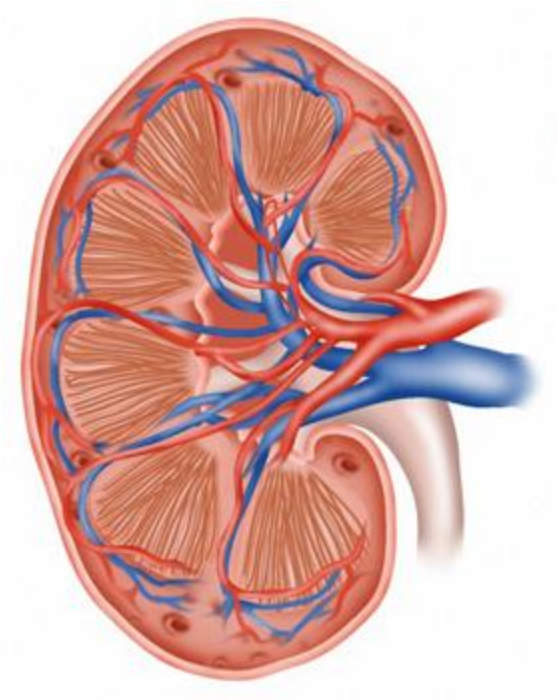
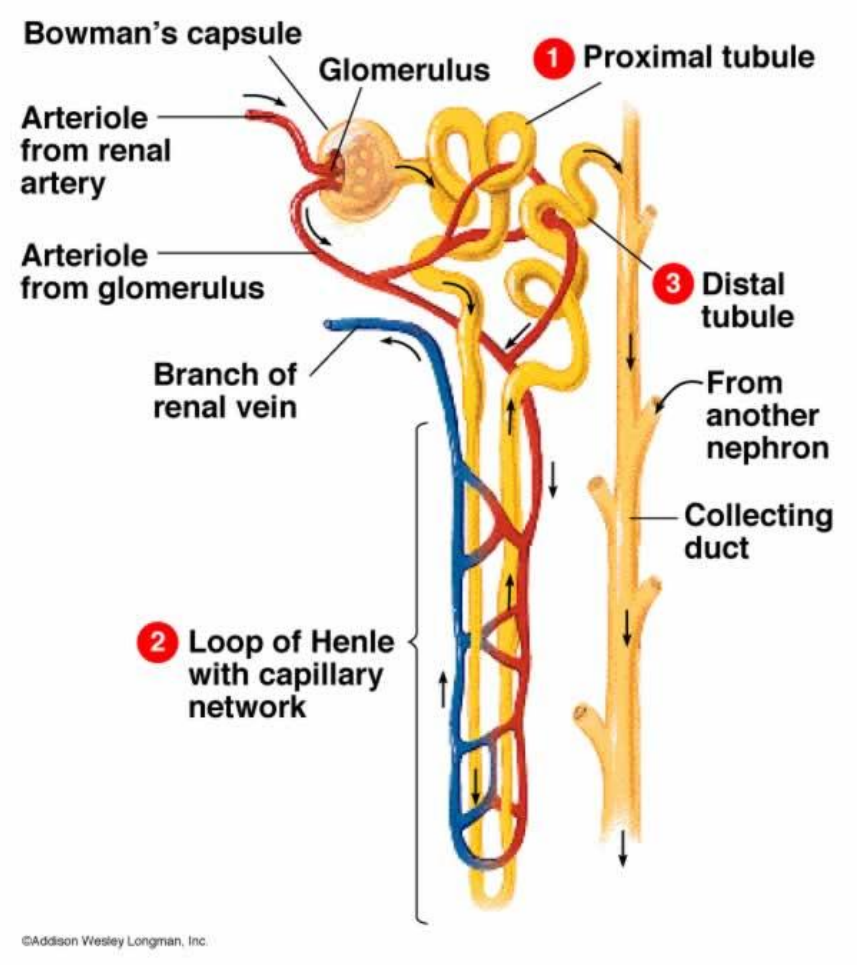
Renal Failure

Normal Kidney Function

- Filters 1600 L of blood/day
- Makes 180 L of ultrafiltrate
- Kidney contains 600,000 to 1.4 million nephrons

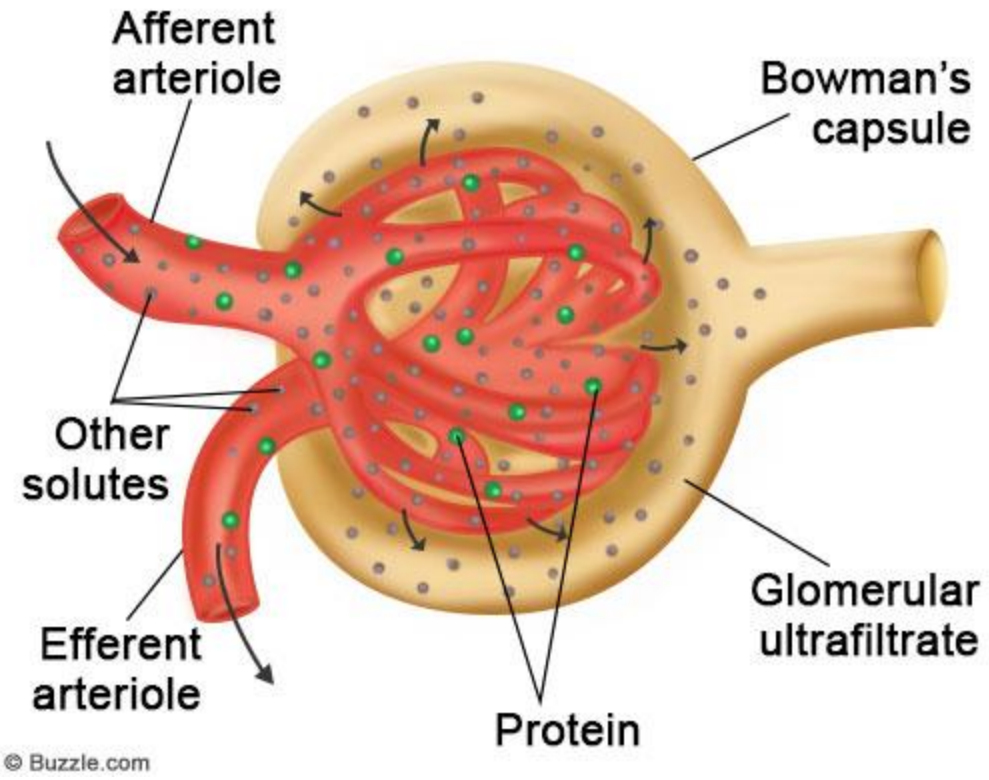
Nephron




Bowman's capsule
Glomerulus
1 Proximal tubule
Arteriole from renal artery
Arteriole from glomerulus
3 Distal tubule
Branch of renal vein
From another nephron
Collecting duct
2 Loop of Henle with capillary network
©Addison Wesley Longman, Inc.

glomerulus

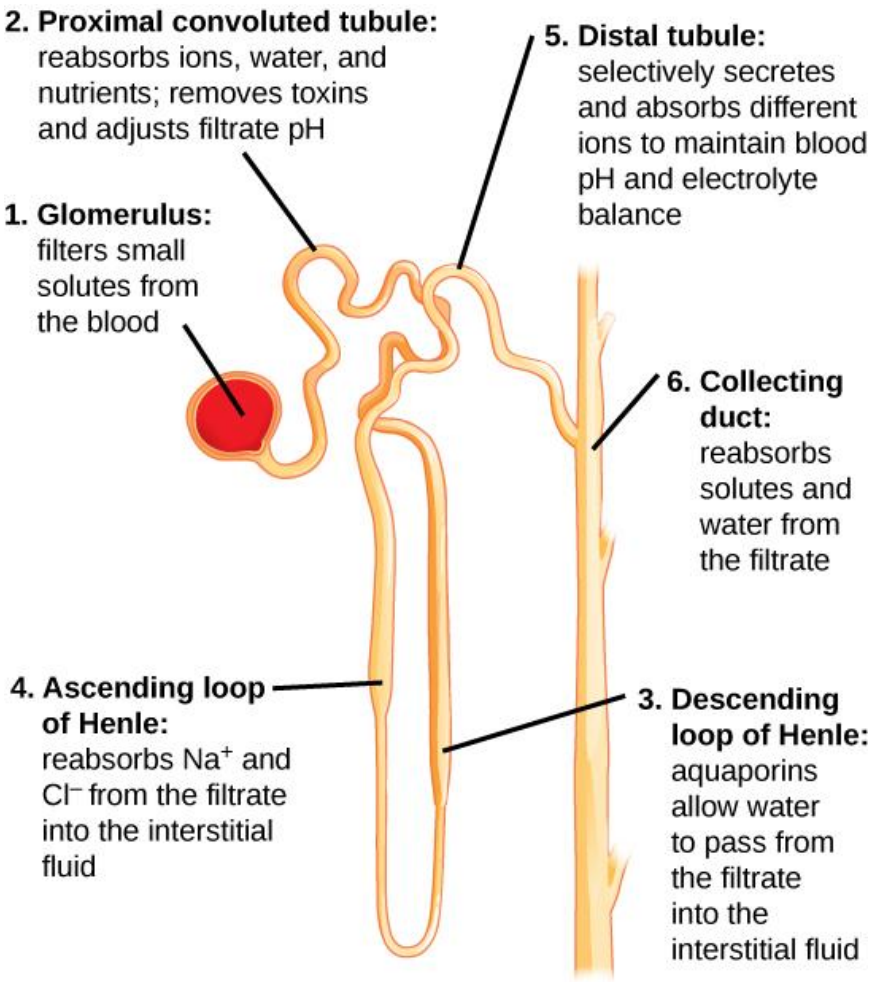
Filtered:
Ammonia
Protein
Amino acids
Creatinine
Uric acid
Electrolytes
Some are then reabsorbed



Normal Glomerular Filtration Rate (GFR)

- GFR: sum of the filtration rates of all functioning nephrons.
- Diagnosed by creatinine clearance
- 90-140 ml/min in men
- 80-125 ml/min in women

Nephron


2. Proximal convoluted tubule: reabsorbs ions, water, and nutrients; removes toxins and adjusts filtrate pH
5. Distal tubule: selectively secretes and absorbs different ions to maintain blood pH and electrolyte balance
1. Glomerulus: filters small solutes from the blood
6. Collecting duct: reabsorbs solutes and water from the filtrate
4. Ascending loop of Henle: reabsorbs Na^+ and Cl^- from the filtrate into the interstitial fluid
3. Descending loop of Henle: aquaporins allow water to pass from the filtrate into the interstitial fluid

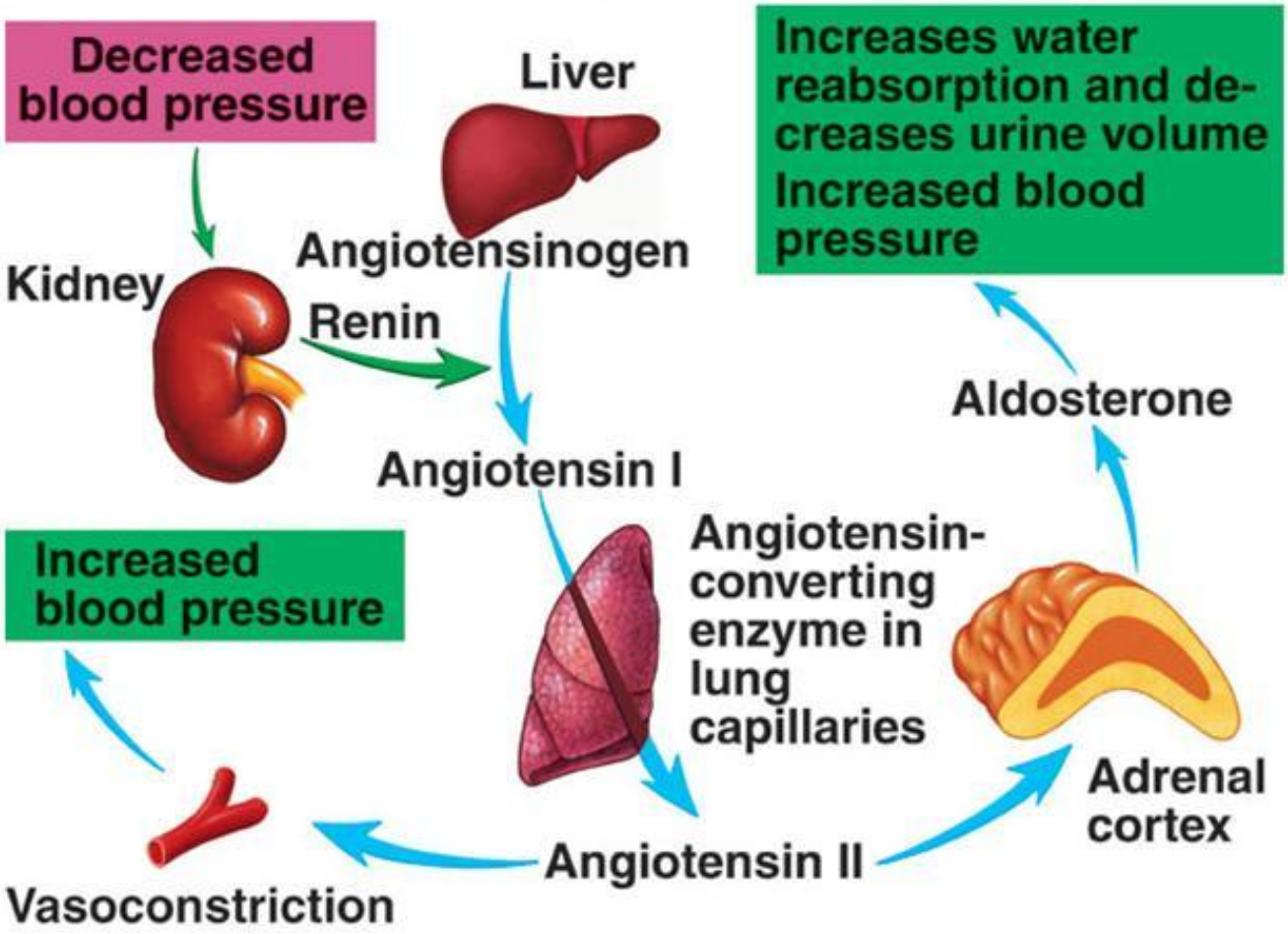
Kidney functions

- **Excretes** waste products from bodily metabolism (urea, uric acid, hormone metabolites, creatinine, excess vitamins and minerals, drugs and poisons). Or it keeps them in the blood if levels are low.
- Runs **acid-base balance** for blood pH. Through bicarbonate, H goes to the kidney and is excreted or reabsorbed.
- **Endocrine function**: calcitriol from Vit. D, erythropoietin, renin.

Kidney Functions cont'd

- **Electrolyte and inorganic ion balance:** Na, K, Cl, HCO_3, H, Ca, P.
- **Fluid balance in body** from ADH.
- Maintains **osmolality** within range.
- Maintains plasma volume

Renin-angiotensin aldosterone system



Potassium

- Kidney matches K excretion with intake (90-95% excreted by kidney)
- Cardiac neuromuscular activity (action potential)
- DNA and protein synthesis
- Cell division
- Enzyme function

Phosphorus

- Too much phosphorus in the blood will cause calcification of soft tissues

Risk Factors for Renal Failure

Most common: Diabetes, hypertension

Family History
Obesity
Old Age
Frequent urinary tract infection
Kidney stones
Autoimmune diseases

- Goodpastures Syndrome
- Lupus

Etiology of renal failure

CHRONIC RENAL FAILURE

- Chronic hypertension
- Chronic diabetes mellitus

Secondary causes

- Glomerulonephritis
- Kidney stones (obstructions)
- Nephrotic syndrome
- Nephritic syndrome
- Exposure to some drugs and toxins
- Pylonephritis
- Tumors

Nephritic Syndrome

- Diseases that cause inflammation of the glomerulus.

Nephrotic Syndrome

- Large proteins are able to pass through the glomerulus and are excreted
- Hypoprotienemia, edema

Chronic Renal Failure

- Happens over a period of years
  - Kidney is adaptive to changes from disease, and imbalances of salt and water are not noticeable until <25% kidney function.
- Irreversible

Stage 1: Reduced Renal Reserve

- GFR - 50% (<90 ml/min)
- Elevated BUN, creatinine
- May not have clinical symptoms

Stage 2: Renal Insufficiency

- GFR reduction below 25% (60-89 ml/min)
- Mild clinical symptoms
  - Azotemia(wastes accumulate in blood)
  - Urine concentration impaired→nocturia
  - Mild anemia (lack of erythropoietin)
- Compensation of nephrons(damage may be tubular or glomerular)

Stage 3: Renal Failure

- GRR< 20% (30-59 ml/min)
- Symptoms
  - Azotemia
  - Acidosis
  - Urine dilution impaired
  - Severe anemia
  - Hypernatremia, hyperphosphatemia, hyperkalemia
  - Non-renal organ systems affected

Stage 4: Severe

- GFR 15-29 mL/min

Stage 5: End-Stage kidney disease

- Almost no GFR-<15 mL/min
- BUN >100 mg/dL, Creatinine:10-12 mg/dL
- No excretion or reabsorption
- Bone and mineral disorders
  - Decrease in P excretion→hypocalcemia, increased PTH→bone reabsorption of Ca→ bone disorder, vascular calcification.
- Uremia (elevated urea and creatinine in blood leads to fatigue, vomiting, anorexia, nausea, diarrhea, neurological problems)

Stage 5 cont'd

- Impairments in:
  - Creatinine and Urea
    - Blood levels are increased because they can't be filtered
  - Sodium and Water balance
    - Kidney cannot conserve Na efficiently with high levels
    - Urinary concentrations fixed
  - Phosphate and calcium balance
    - High P, low Ca
  - Acid base balance
    - Metabolic acidosis
  - Potassium balance
    - High K due to lack of excretion

Organ Systems Affected

- Skeletal
  - bone demineralization
- Cardiopulmonary
  - Hypertension
  - Chest pain
  - Pulmonary edema
- Neurologic
  - Encephalopathy (fatigue, problem solving difficulties)

Organ Systems Affected Cont'd

- Hematologic-erythropoietin
  - Anemia
  - Clotting problems
- Gastrointestinal-urea retention
  - Anorexia
  - N/V
  - Ulcers in mouth
  - Gastrointestinal bleeding
  - pancreatitis

Organ Systems Affected Cont'd

- Endocrine and reproductive
  - Growth problems
  - Osteomalacia
  - Sexual disfunction (amenorrhea, infertility)
- Integumentary-urochromes(hemoglobin metabolite, calcium)
  - Pigmentation
  - Pruritus (itch)
- Immunologic
  - Increased risk of infection

Bone Health

- Bone serves as a reservoir of calcium
- Homeostasis is through the action of osteoclasts (reasorption or breakdown of bone) and osteoblasts (formation or production of bone)
- Regulated by PTH and vit. D_3

PTH

- Secreted in response to hypocalcemia or vit. D deficiency
- Stimulates kidneys to convert vit. D to its active form
- High levels =bone loss
- Increases with renal failure

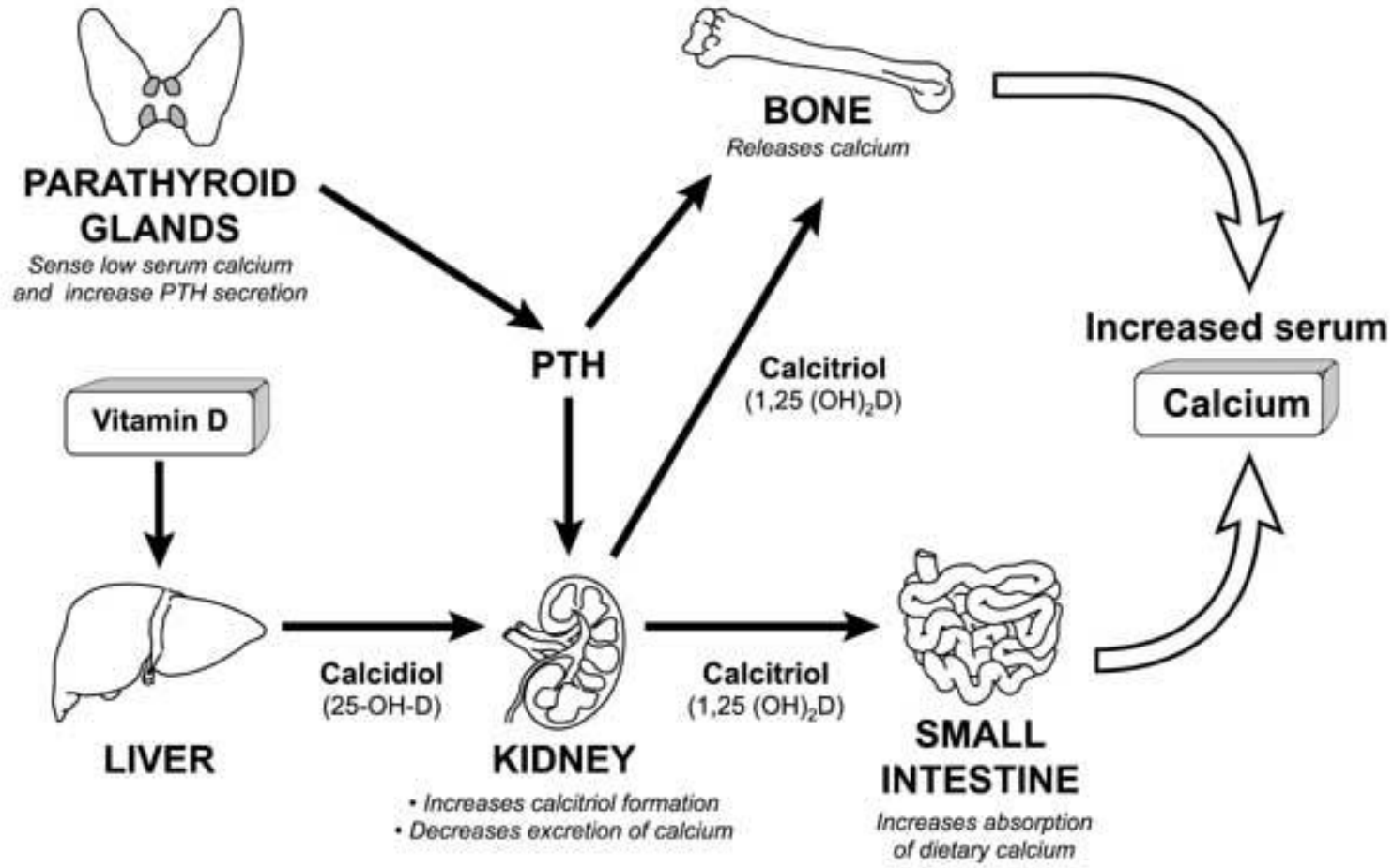
Phosphate

- Excreted by kidney
- Excretion should equal dietary intake
- Depends on Ca metabolism
- Increases with low pH
- Stimulate PTH production
- Increases with renal failure

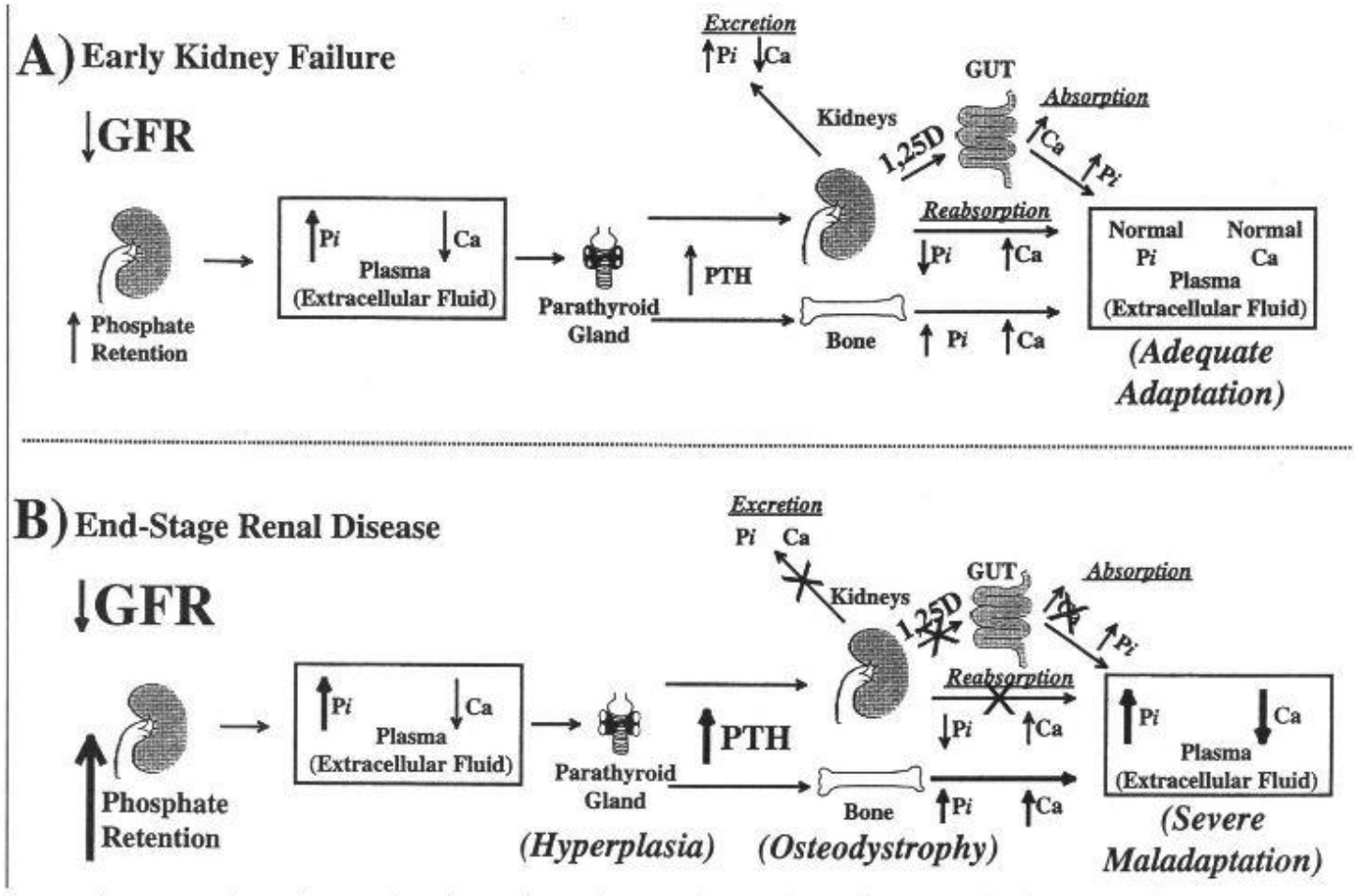
Vitamin D

- 1,25 dihyroxyvitamin D
- Inhibits the release of PTH
- Decreases with renal failure

Vitamin D and Calcium Metabolism



Calcium and Phosphorus Metabolism



Iron

- Recycled RBC's and food
- EPO decreased in renal failure
- RBC destruction
- Oral iron alone is ineffective
- Ferritin

Drugs

- Phosphate Binders
- Vitamins
  - Increased need for water soluble vitamins
- Iron
  - Needs increase with EPO therapy (IV)
- EPO
  - IV or IM

Drugs continued

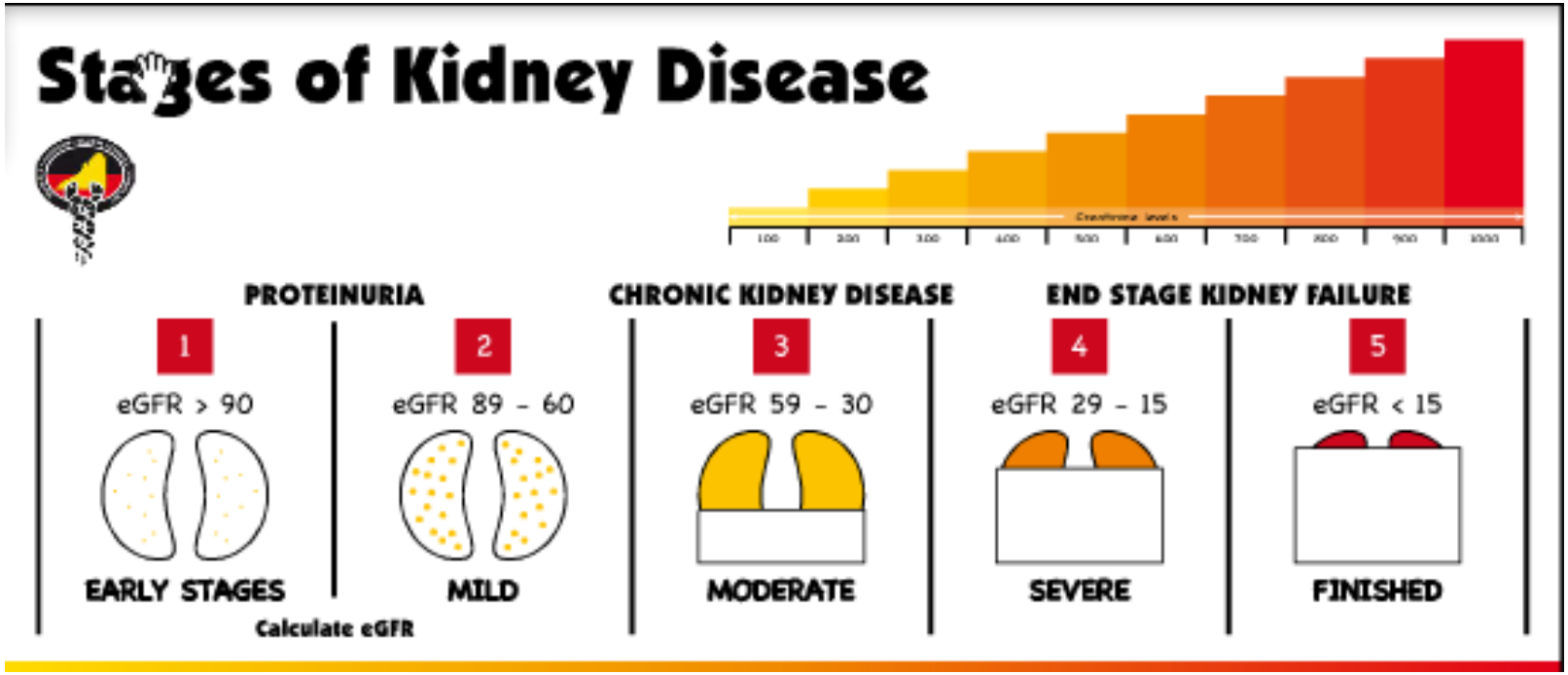
- Activated Vitamin D
  For management of hyperparathyroidism (oral or IV)
- Biphosphates
  Inhibit bone reasoprtion by blocking osteoclast activity (oral or IV)
- Calcium Supplements
- Calcimimetics
  Mimic calcium and bind to parathyroid gland

Complimentary Therapy

- Flaxseed oil supplementation to decrease C-reactive protein levels in chronic hemodialysis patients.
- Malnutrition and chronic inflammation can effect survival
- Can improve therapeutic results.

Diagnoses

- GFR <15mL/min
- BUN >100mg/dL
- Cr 10-12mg/dL



Labs

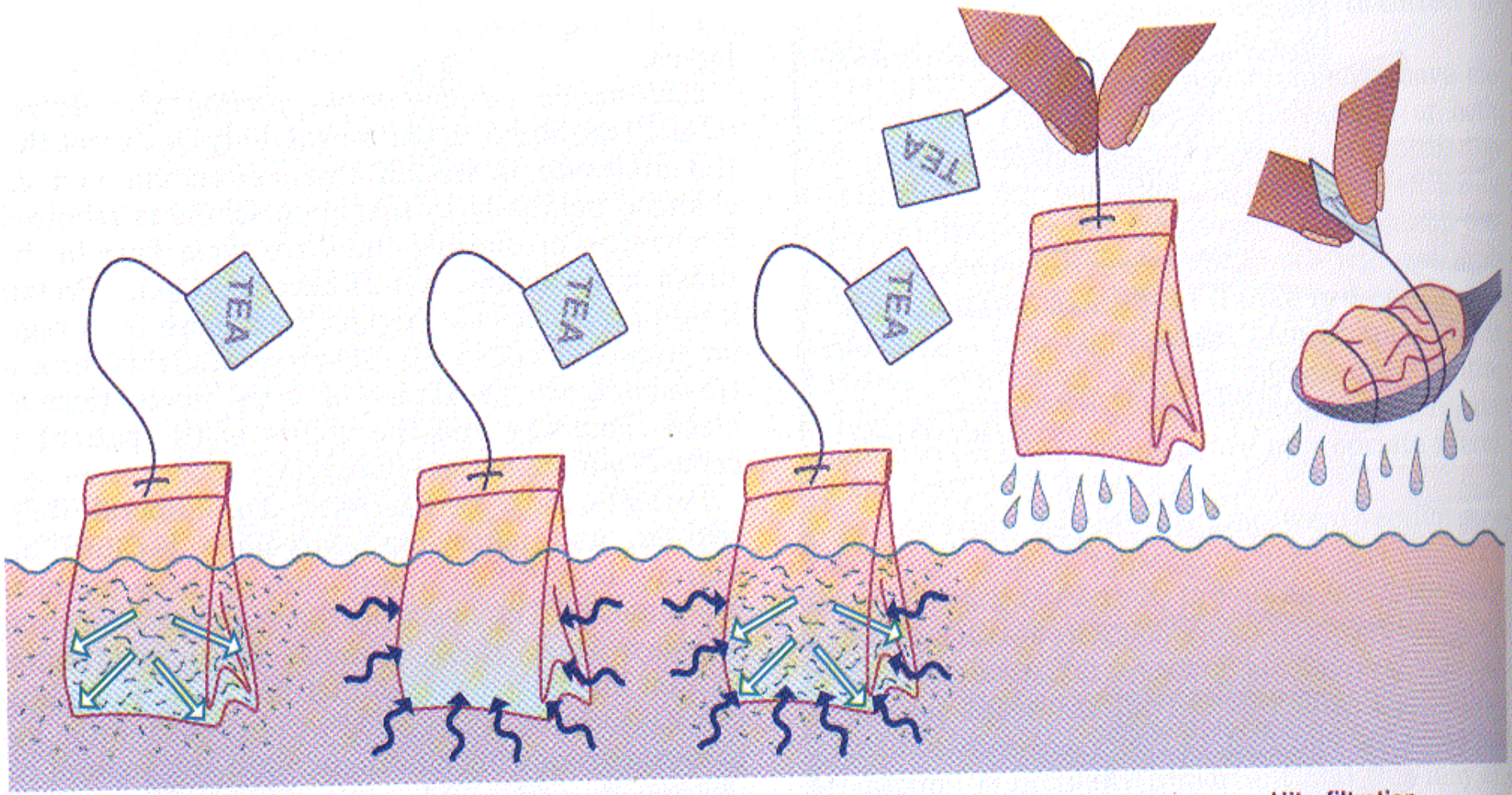
- Sodium-- ↓
- Potassium-- ↑
- Chloride-- WNL
- CO_2-- WNL
- HCO_3-- ↓
- BUN-- ↑
- Creatinine serum-- ↑
- GFR-- ↓

- Inorganic phosphate-- ↑
- Calcium-- ↓
- Anion Gap-- ↑
- Protein-- ↓
- Albumin-- ↓
- Ammonia ↑
- hematocrit ↓
- hemoglobin ↓

Dialysis and Transplants

Dialysis

- Dialysis Treatment Options
  - HD- Hemodialysis
    - Conventional dialysis
    - Nocturnal dialysis
  - PD- peritoneal dialysis
    - CAPD- Continuous ambulatory peritoneal dialysis
    - CCPD- Continuous cyclic peritoneal Dialysis



Diffusion
is the passage of particles through a semipermeable membrane. Tea, for example, diffuses from a tea bag into the surrounding water.

Osmosis
is the movement of fluid across a semipermeable membrane from a lower concentration of solutes to a higher concentration of solutes.

Diffusion and **Osmosis**
can occur at the same time.

Filtration
is the passage of fluids through a membrane.

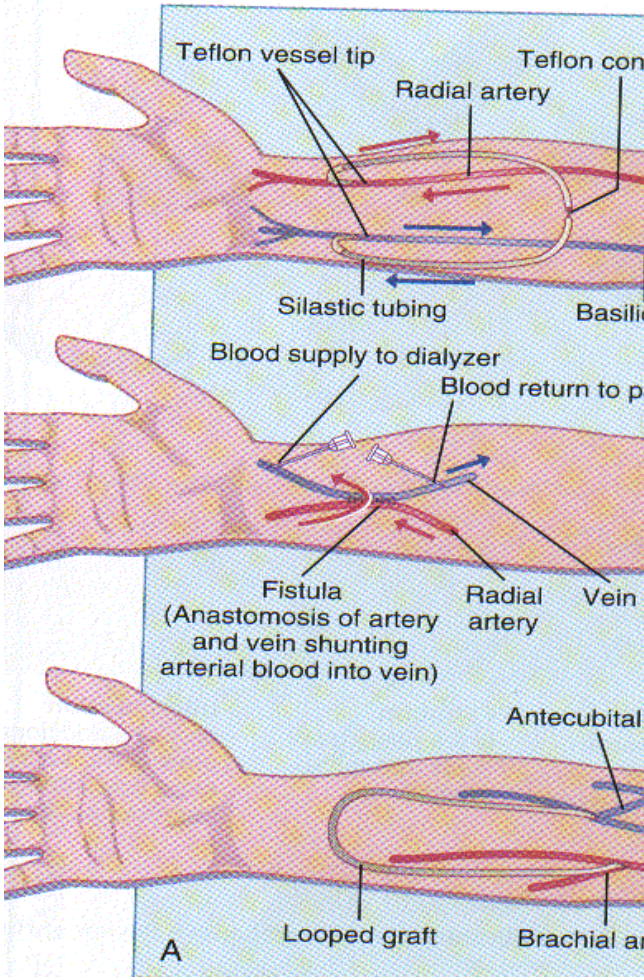
Ultrafiltration
provides additional pressure to squeeze extra fluid through the membrane.

Dialysis

- Factors affecting treatment type
  - Availability of family or friends to assist with therapy (ability to perform process)
  - Type of water supply to the home
  - Previous abdominal surgeries
  - Body size
  - Cardiac status
  - Presence of poor vascular access
  - Desire to travel
  - others

Hemodialysis

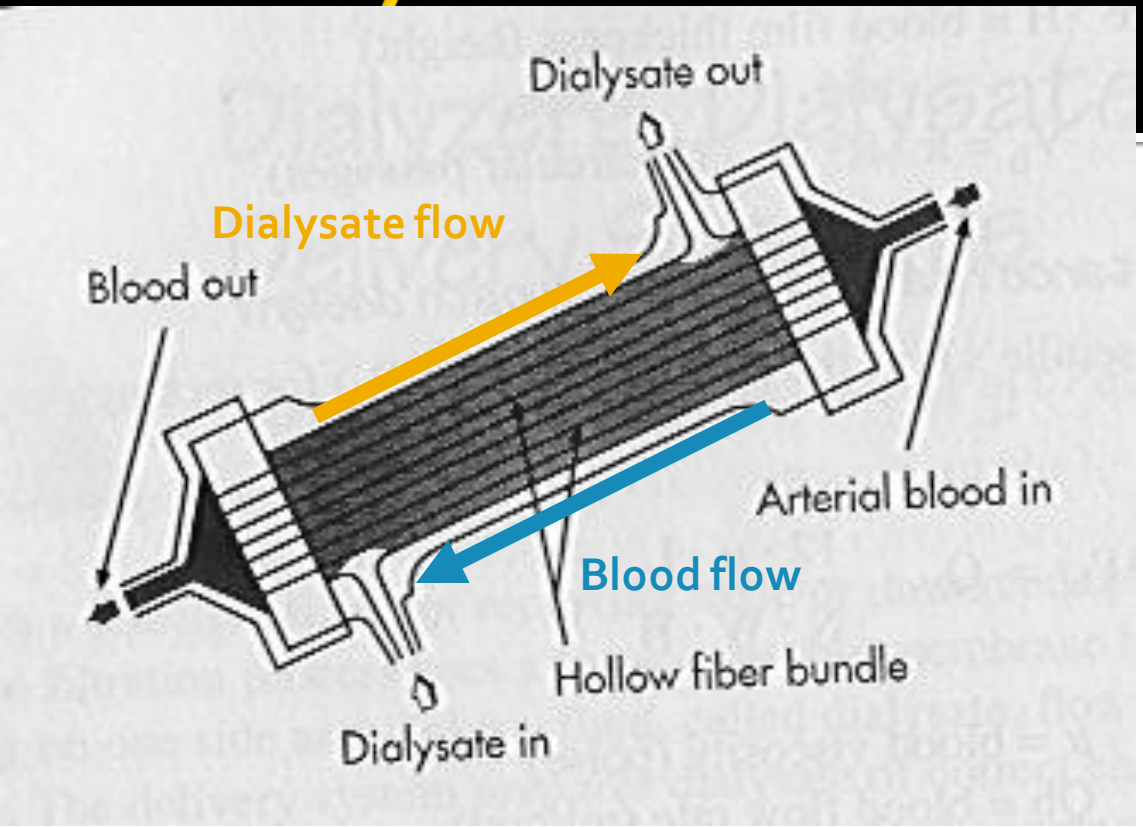
- Permanent access to bloodstream via fistula
  - Fistula- the connection of an artery and vein
    - If blood vessels are week a graft is implanted
  - Needles (large)- inserted into fistula before dialysis and removed when completed
- Requires purified water
  - Water is mixed to create different 'baths' of minerals



Hemodialysis

- Water treatment system

Dialyzers


Dialysate out
Dialysate flow
Blood out
Arterial blood in
Blood flow
Hollow fiber bundle
Dialysate in


13
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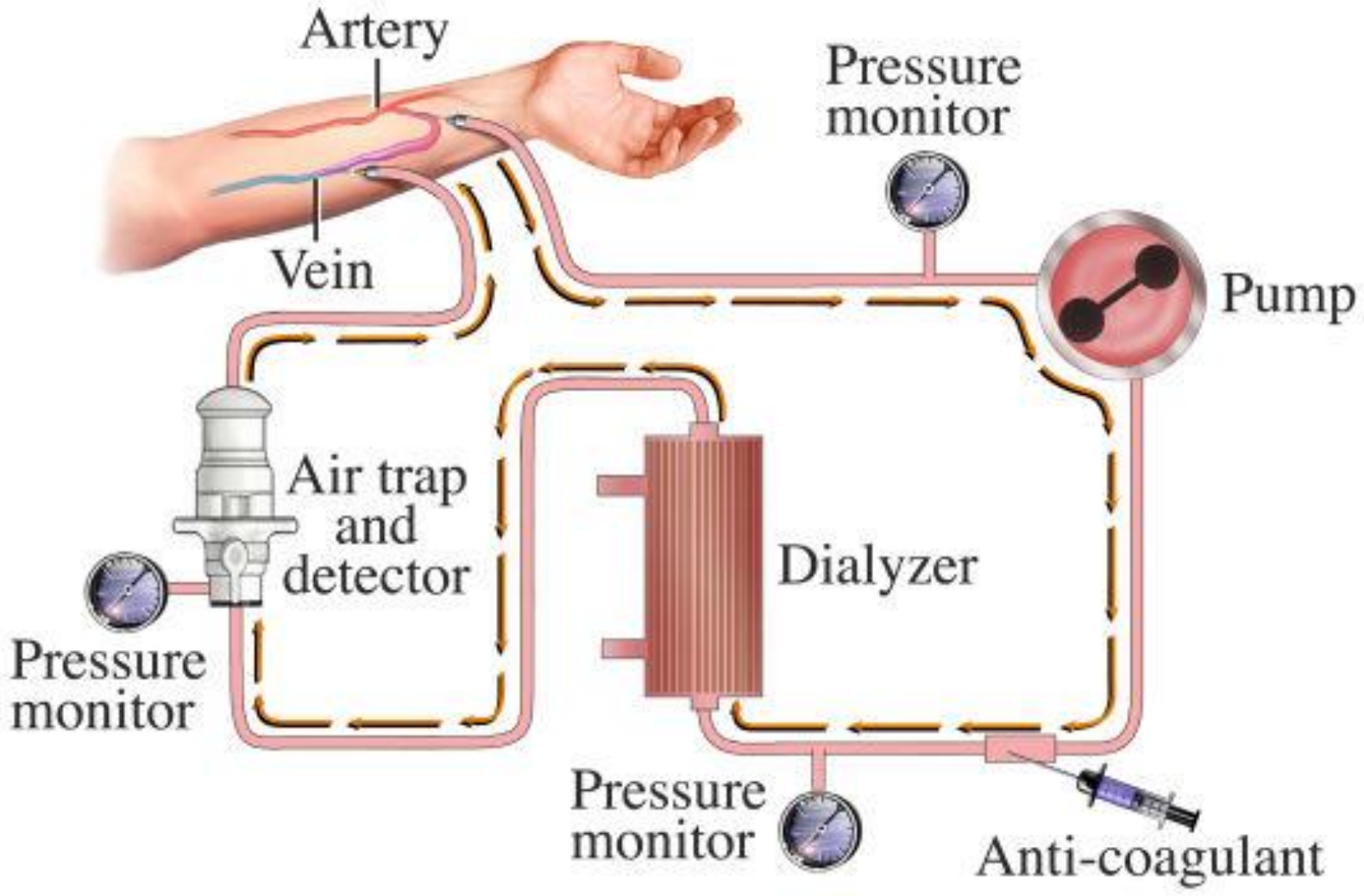
Hemodialysis

- Dialyzer contains fluid & electrolyte content similar to normal plasma
- In dialyzer, waste products & electrolytes move by diffusion, ultrafiltration, & osmosis from blood to dialysate & are removed
- Treatment frequency
  - Outpatient: 3-5 hrs 3x week
  - Home daily dialysis: 2-3.5hrs 5-6x week
  - Nocturnal: 3-6x week 8 hrs while sleeping

Hemodialysis



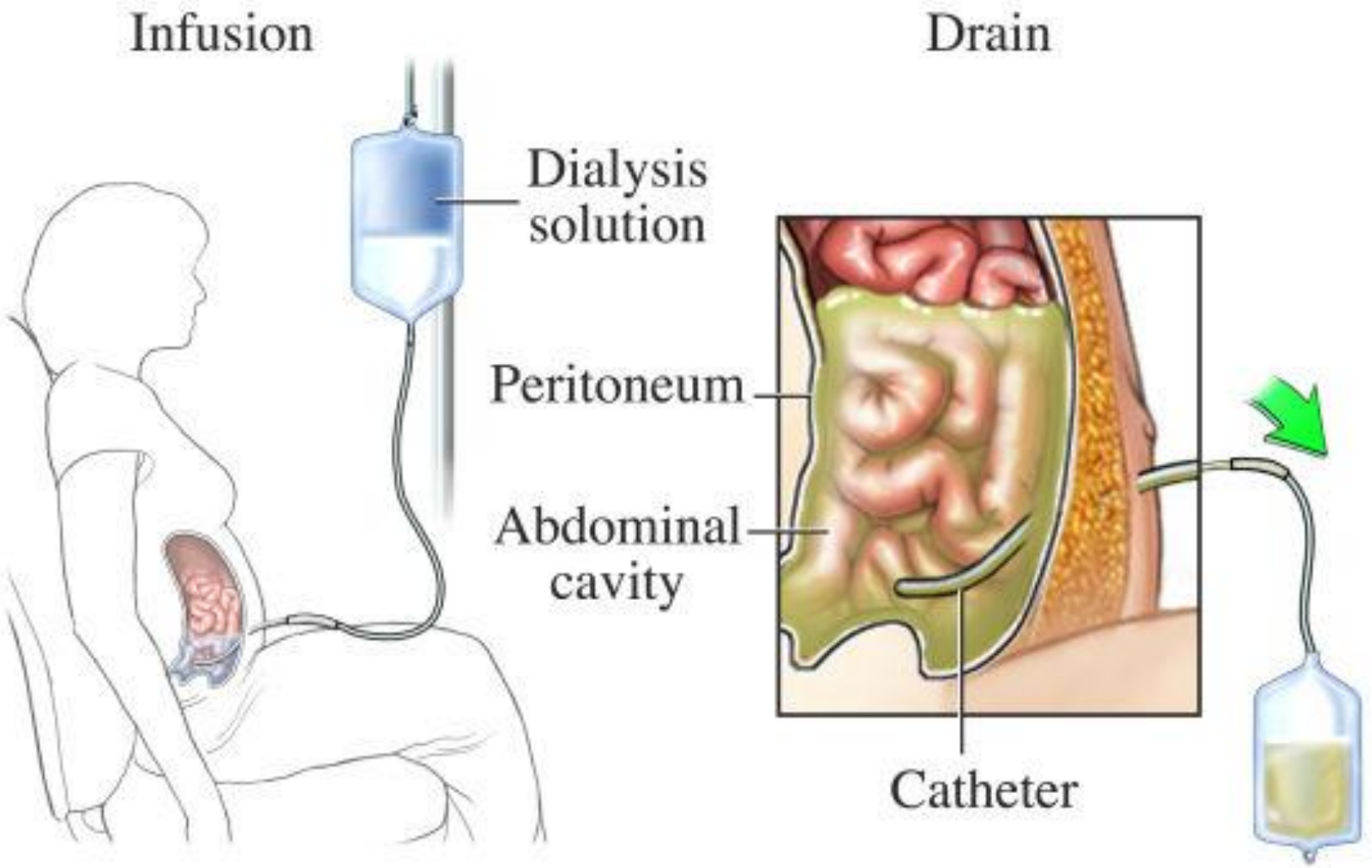
Peritoneal Dialysis

- Uses body's peritoneum to diffuse waste products
- Catheter is implanted in the abdomen and into the peritoneal cavity
- Dialysate is instilled into the peritoneum
- Diffusion carries waste products from the blood through the peritoneal membrane and into the dialysate; water moves by osmosis
- The fluid is removed and new solution added

Peritoneal Dialysis

- CAPD- dialysate is left in peritoneum and exchanged manually, via gravity
  - Exchanges are done 4-5 x daily
- CCPD- one dialysate is left in peritoneum for extended periods. Main treatment is done at night by a machine that does the exchanges

Peritoneal Dialysis



Advantages/complications of PD

- Advantages
  - Avoidance of large fluctuations in blood chemistry
  - Longer residual renal function
  - Ability to live a more normal lifestyle
- Complications
  - Peritonitis
  - Hypotension (requires fluid and Na+ replacement)
  - Weight gain b/c absorbing extra 400-800 kcal from glucose in dialysate

Peritoneal Dialysis

- Alternative to dialysate
- Icodextrin- A long-chain, non-absorbable sugar
- Offers superior fluid removal, ultrafiltration, without the excess dextrose absorption.
- Useful for patients with diabetes and excess weight gain
- Can cause other complications and is costly

HD vs PD

TABLE 48-1 Advantages and Disadvantages of Hemodialysis

Advantages

1. Higher solute clearance allows intermittent treatment.
2. Parameters of adequacy of dialysis are better defined and therefore underdialysis can be detected early.
3. Technique failure rate is low.
4. Even though intermittent heparinization is required, hemostasis parameters are better corrected with hemodialysis than peritoneal dialysis.
5. In-center hemodialysis enables closer monitoring of the patient.

Disadvantages

1. Requires multiple visits each week to the hemodialysis center, which translates into loss of control by the patient.
2. Disequilibrium, dialysis hypotension, and muscle cramps are common. May require months before the patient adjusts to hemodialysis.
3. Infections in hemodialysis patients may be related to the choice of membranes, the complement-activating membranes being more deleterious.
4. Vascular access is frequently associated with infection and thrombosis.
5. Decline of residual renal function is more rapid compared to peritoneal dialysis.

TABLE 48-2 Advantages and Disadvantages of Peritoneal Dialysis

Advantages

1. More hemodynamic stability (blood pressure) due to slow ultrafiltration rate.
2. Increased clearance of larger solutes, which may explain good clinical status in spite of lower urea clearance.
3. Better preservation of residual renal function.
4. Convenient intraperitoneal route for administration of drugs such as antibiotics and insulin.
5. Suitable for elderly and very young patients who may not tolerate hemodialysis well.
6. Freedom from the "machine" gives the patient a sense of independence (for continuous ambulatory peritoneal dialysis).
7. Less blood loss and iron deficiency, resulting in easier management of anemia or reduced requirements for erythropoietin and parenteral iron.
8. No systemic heparinization required.
9. Subcutaneous versus intravenous erythropoietin or darbepoetin is usual, which may reduce overall doses and be more physiologic.

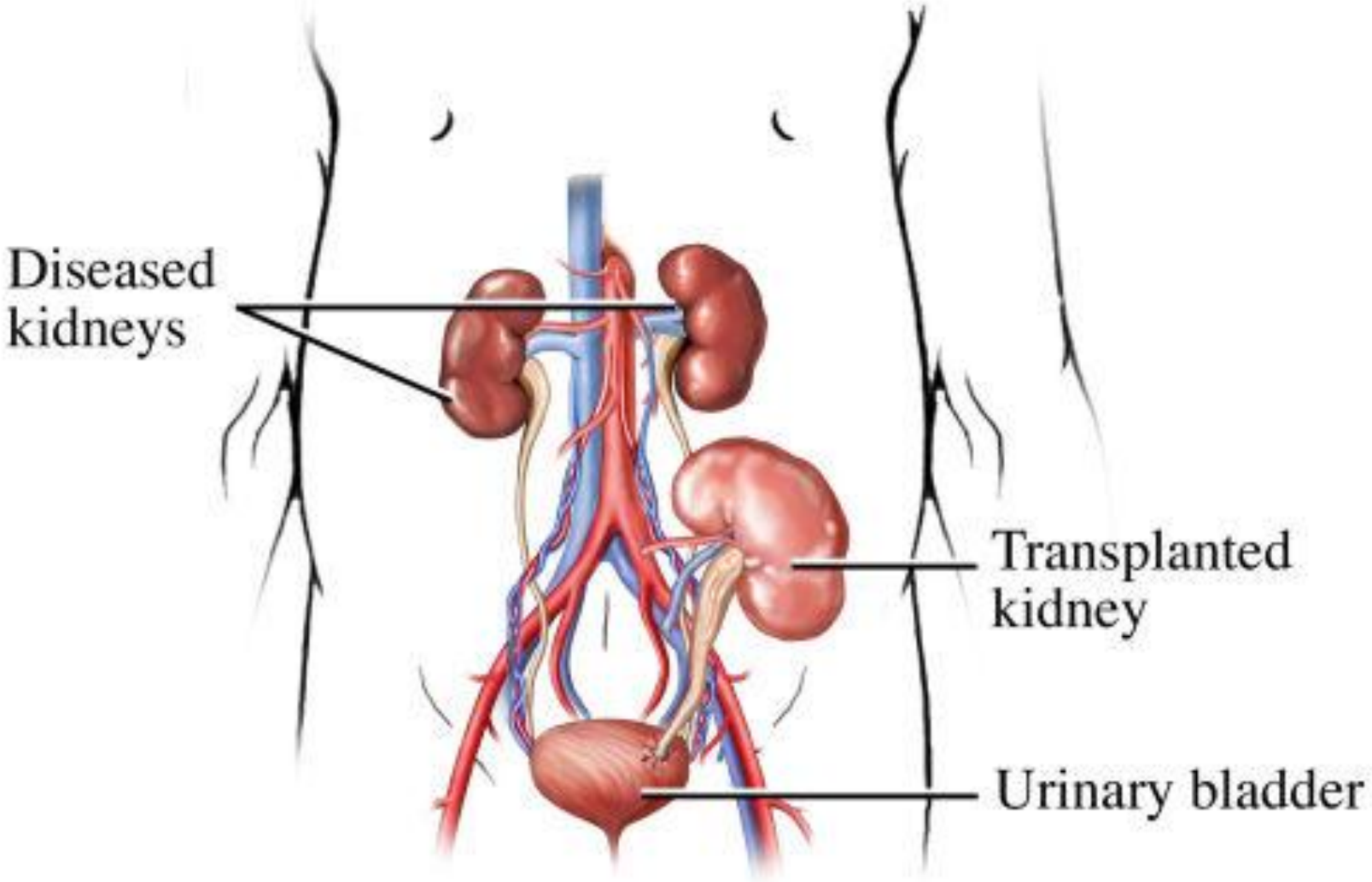
Disadvantages

1. Protein and amino acid losses through peritoneum and reduced appetite owing to continuous glucose load and sense of abdominal fullness predispose to malnutrition.
2. Risk of peritonitis.
3. Catheter malfunction, exit site, and tunnel infection.
4. Inadequate ultrafiltration and solute dialysis in patients with a large body size, unless large volumes and frequent exchanges are employed.
5. Patient burnout and high rate of technique failure.
6. Risk of obesity with excessive glucose absorption.
7. Mechanical problems such as hernias, dialysate leaks, hemorrhoids, or back pain more common than HD.
8. Extensive abdominal surgery may preclude peritoneal dialysis.
9. No convenient access for intravenous iron administration.

Cochrane Review

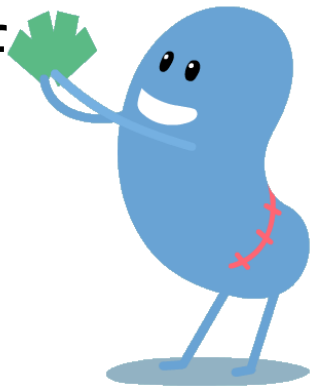
- **CAPD vs. (APD) automated peritoneal dialysis for ESRD**
- **APD beneficial over CAPD**
  - Reduced incidence of peritonitis
  - Reduced mechanical complications
  - Greater psychosocial acceptability
- **APD more beneficial in younger PD populations**
  - Such as patients: employed or still gaining an education due to its psychosocial advantages.

Renal Transplants

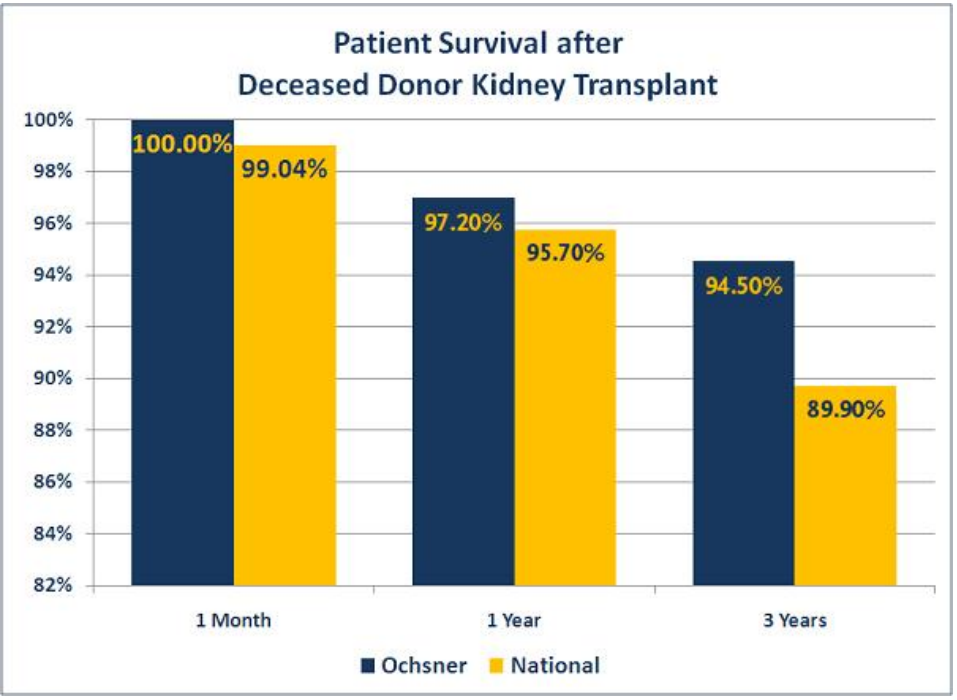


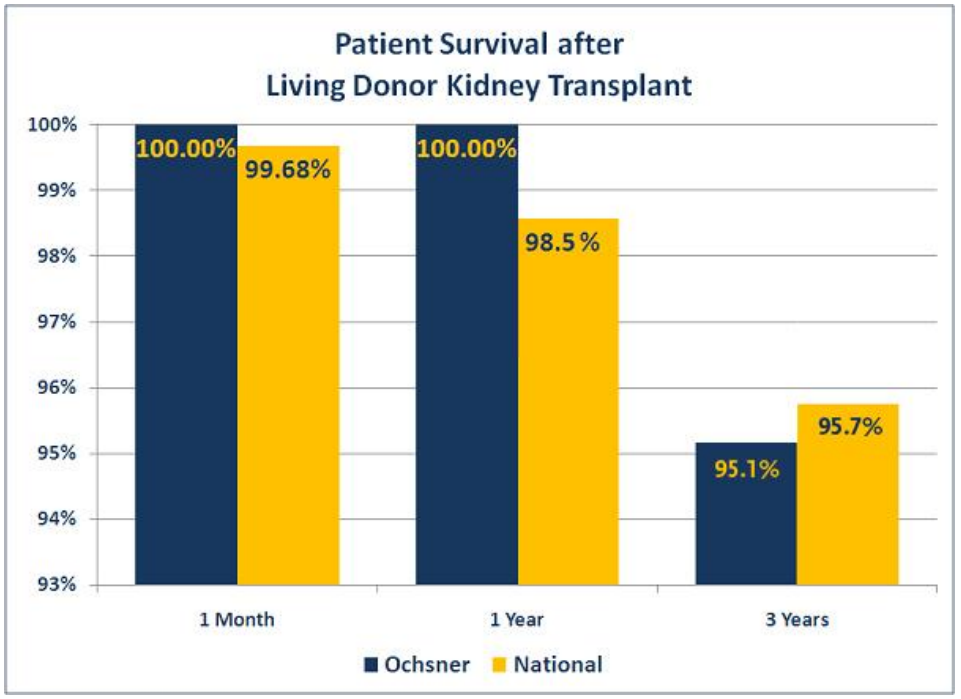
Renal Transplants

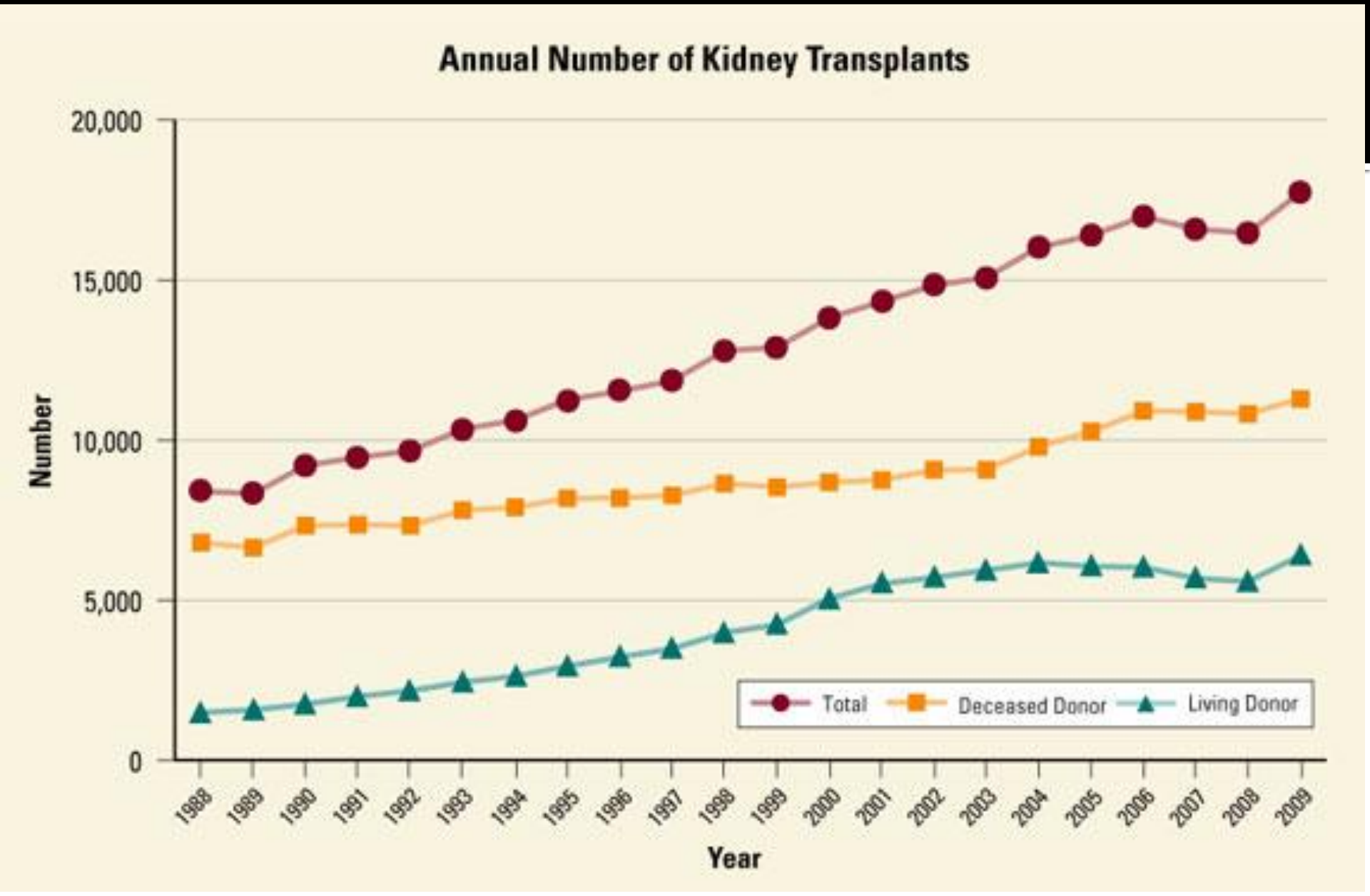
- Most common solid organ transplant
- Is the preferred method of treatment for many end-stage renal disease patients
- Economically advantageous
  - Cost less long term than dialysis
- Insufficient organ donation accounts for the discrepancy between the number of recipients and candidates



Deceased vs Living Donor






Annual Number of Kidney Transplants
20,000
15,000
10,000
5,000
0
Number
Total
Deceased Donor
Living Donor
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Year

Transplants

- 3 phases of care for organ transplant recipients to allow for the adjustment of nutrition priorities during different phases of care

Transplants

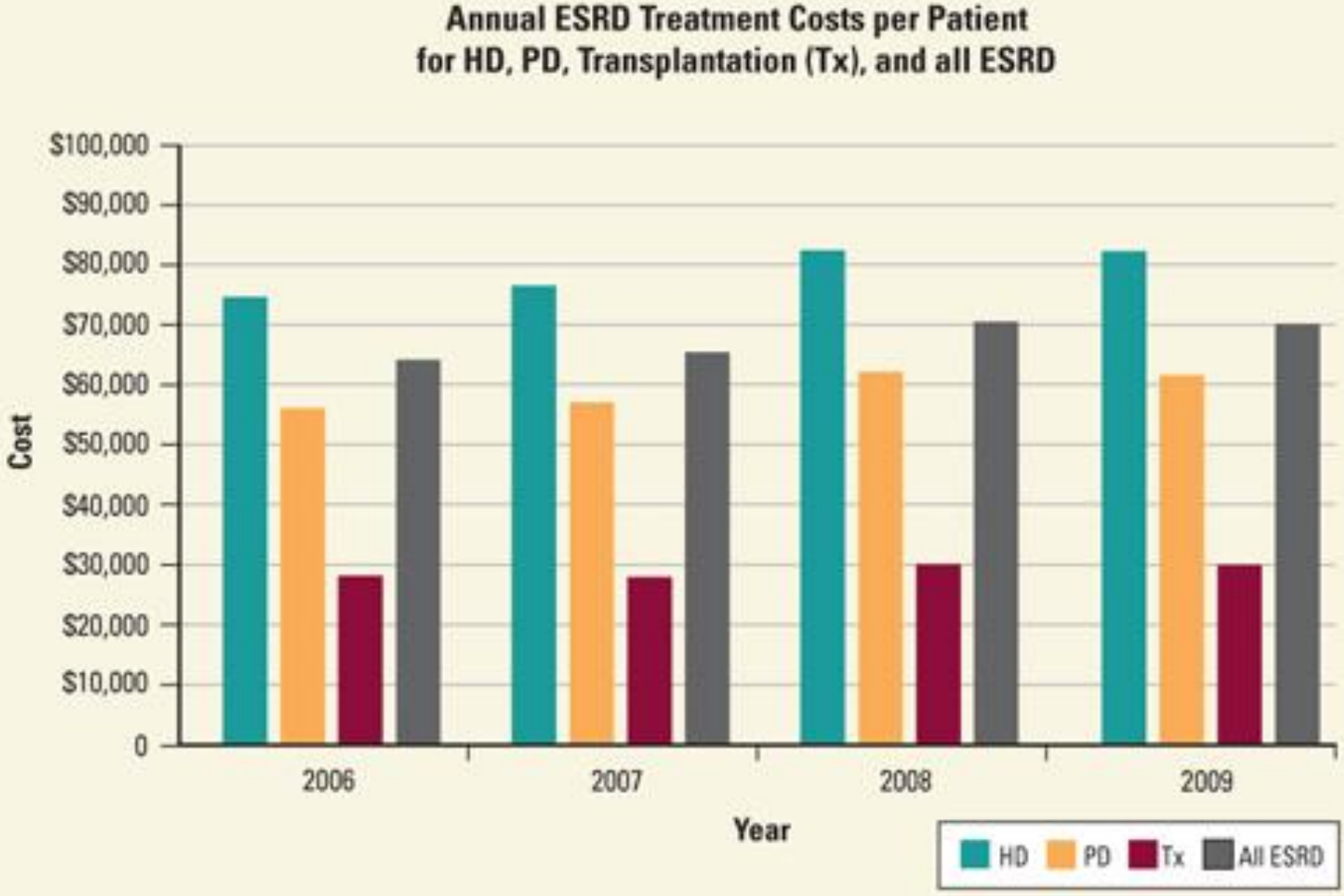
- **Pretransplant**
  - Extensive evaluation is done by RD
    - Includes: medical and dietary history, anthropometric data, biochemical indices, GI evaluation, current renal replacement therapy, compliance to treatment, and more
  - Limited organs available means selection of candidates is an important issue
    - Recipients should meet center-specific weight criteria prior to transplant
      - Obesity or low BMI must be corrected and a healthy weight must be maintained

Transplants

- **Acute posttransplant-** Immunosuppressive therapy
  - Goal to provide adequate kcal & protein for would healing, prevent acute & chronic rejection, minimize toxicity of the agents & rates of infection, while achieving high patient & graft survival
- Induction therapy-short term antilymphocyte antibody medication
- Antirejection therapy- long term
- Multidrug therapy- inhibit adaptive immune but allow nonspecific function

Transplants

- **Chronic posttransplant** (4-6 wks post surgery)
- Monitoring of obesity, dyslipidemia, hyperglycemia, osteoporosis
- Nutritional goals are same as a healthy individual
- Manage weight gain/ obesity


Annual ESRD Treatment Costs per Patient
for HD, PD, Transplantation (Tx), and all ESRD
$100,000
$90,000
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
0
Cost
2006
2007
2008
2009
Year
HD
PD
Tx
All ESRD

Hemodialysis & Peritoneal dialysis

MNT for Dialysis

MNT Goals

1. Prevent deficiency and maintain good nutrition status
2. Enable patient to eat attractive diet which patient's lifestyle as much as possible
3. Control edema and electrolyte imbalance
4. Prevent or delay development of renal osteodystrophy
5. Coordinate patient care with healthcare team
6. Provide initial nutrition education, periodic counseling, and long term monitoring of patients.

Dialysis: Nutrients of Concern

1. Protein
2. Calories (Energy)
3. Fluids
4. Sodium
5. Potassium
6. Iron
7. Phosphorus
8. Calcium

1. Protein

- Increased needs, because dialysis will drain the availability of protein
  - 20-30 g lost within a 24 hr PD
- Recommendation: 1.2-1.5 g/kg of body weight
  - 50% should be HBV (High Biological Protein)
  - HD- 1.2g/kg
  - PD– 1.2-1.5 g/kg

Protein Suggestions

- Red meats: Taste nor smell can be tolerated
  - Can tolerate: Eggs, tofu, lamb, and white meats.
- Spices can hide taste and serve animal protein cold to minimize urea taste.
- May need to remove phosphate restriction to provide enough protein into body

2. Calories

- Between 20-45 kcal/kg
  - Lower amount: Transplantation (30-35kcal) and PD Patients
  - High amount: Nutritionally depleted patients

3. Fluids and Na

- Majority: Need to restrict sodium and fluid intakes
  - Determined based on blood pressure, edema, fluid weight gain, serum sodium level, and dietary intake
- ↑ sodium intake → ↑ thirst → ↑fluid gain → HPTN
- **Solution**: ↓ sodium intake → limits thirst → prevents large intradialytic fluid gains
- HD: Weight gain of 4-5 lbs from increased fluid in vasculature between dialyses

3. Fluids and Na

- Fluids: 750mL/day + Urine Output (in mL)
  - Includes liquids at room temperature (Fluid not in solid foods, such as fruit)
- Na: 87-130 mEq
  - Average: Only 10-25% is from added salt while cooking
- What to teach patient?
  - How to deal with thirst, without drinking.
  - Examples: Ice chip sucking, cold sliced fruit, sour candies, artificial saliva
  - How to read Salt on a food label → "Na"

4. Potassium

- Depends on serum potassium level, urine output, medications, and frequency of HD

- Normal : 75-100 mEq
  - ESRD: 60-80 mEq
  - Anuric patient: 51 mEq

Conversion Factors (p. 1047)

$$\frac{\text{mg} * \text{valence}}{\text{Atomic weight}} = \text{millequivalents}$$

$$\frac{\text{mEq} * \text{atomic weight}}{\text{valence}} = \text{milligrams}$$

Mineral	Atomic weight	valence
Na	23	1
K	39.1	1
Ca	40	2
Cl	35.5	1
P	30.97	3.5

Equivalents

Na^+

- 1 mEq = 23 mg Na^+ (23 * 20-40 = 460-920 mg)
- 1 mg Na^+ = 43 mEq Na^+

K+

- 1 mEq = 39 mg K^+ (39 *30-50 = 1170 –1950 mg)
- 1 mg K^+ = 26 mEq K^+

4. Potassium

- What to teach patients?
  - Example: Low Na foods include “K Cl “as a salt substitute, rather than Na Cl.

- Non related reasons for elevated potassium levels:
  - Missed dialysis treatments
  - ↑↑ conc of K in dialysate bath
  - DM
  - Acidosis
  - Constipation
  - GI bleeding
  - Medication
  - Blood Transfusions
  - Major Trauma
  - Chemotherapy/Radiation therapy.

5. Phosphorus

- Normally: 99% of excess is excreted.
- HD and PD patients experience ½ gain of phosphate consumed daily.

- How is it lowered?
  - Restrict to <1200 mg/day.
  - How? ↑ protein diet = ↑ phosphorus.

- Non meat sources- ↑ in phosphorus.
  - Difficult to separate phosphorus and protein.

- Naturally occurring phosphate is 60% absorbed.
- Phosphate additives are 100% absorbed

5. Phosphate

- GOAL: Balance of dairy, nuts, legumes, and processed foods, while encouraging HBV protein to meet dietary needs.

- Phosphate binding medications: Bind excess dietary phosphate and transport it through GI tract for elimination, preventing absorption into blood.
  - Teach patient:
    - Which medications are phosphate binding medications?
    - Absorbed best with snack/meal and medication

5. Phosphate

- Protein intake will override phosphorus intake
  - ↑ Protein = ↑ Phosphate
- ↑ Calcium = ↓ Phosphate
- ↓ Phosphate = ↓ Vitamin D
- Absorption of Ca and Phosphate is facilitated by an increase in activated Vit D.
  - No active Vitamin D = No complete absorption of Ca and Phosphate

6. Iron

- ↑ need for Fe
- Can be supplemented orally or through I.V.
- Iron deficiency anemia caused by:
  1. The inability of kidney to produce EPO
  2. ↑ destruction of red blood cells secondary to circulating uremic waste products
  3. Blood loss with dialysis or blood sampling

7. Calcium

- **GFR ↓, serum calcium levels ↓**
  - **↓ ability of the kidney to convert to inactive Vit D to its active form**
  - **The need for serum Ca ↑ as serum phosphate levels ↑**
- **If Ca is above normal, Vit D needs to ↓**
- **Many patients on dialysis suffer from hypocalcemia regardless of calcium supplementation**
  - Absorbed through other receptors besides the kidneys.

7. Calcium: Sensipar (Cinacalcet)

- For secondary hyperparathyroidism (HPT) in CKD patients on dialysis

- When taking sensipar:

1. ↓ PTH on parathyroid gland
2. When PTH ↓: Ca and Phosphorus ↓
   - → Causes them to release less PTH
   - → Less calcium and phosphorus are released from your bones

- Take with food or shortly after a meal

MNT Transplantation

MNT Kidney Transplantation

- Based mainly on metabolic effects of required immunosuppressive therapy

- First 6 weeks after surgery: Prevent negative nitrogen balance
  - Protein =1.2-1.5 g/kg of IBW
  - 30-35 kcal/kg IBW
  - NA: 2-3 g/day
    - Minimize fluid retention and help control blood pressure.

Kidney Transplantation

- **Recovery**
  - Calorie restriction for overweight
  - Protein : 1 g/kg IBW
  - Common: Hypophosphatemia and mild hypercalcemia
  - Fluid: 2L a day
    - Needs depend on urine output
  - Lipids: usually have elevated serum triglycerides or cholesterol
    - Low fat diet: Aid in lowering cardiac complications
    - Limit total fat
    - Cholesterol: <300mg/day

Case Study #19

Case Study: #19

Background Information:

- Height: 157.4cm
- Weight: 77.1kg
- BMI: 31.3
- **Career: Postal Service**

Medical History:

- Hypertension
- 2x transplants
- Membranoproliferative glomerulonephritis
- Anemia of chronic kidney disease

Lab Values

- BUN: 124mg/dL high
- Creatinine: 6.8mg/dL high
- GFR: 6mL/min/1.73m^2 low
- Phosphate: 11.9 high
- Calcium: 8.3 low
- Protein: 5.9 low
- Alb: 3.4gdL low
- Hbg: 6.6g/dL low
- Hct: 19% low
- Ferritin: low

Diagnosis

Chronic renal failure *related to* a failed transplant *as evidenced by* low GFR and high BUN and Creatinine lab values.

Recommendations

- **Calories: 1900 – 2300**
- **Protein:** 90-110 g
- **Na: 2-4 g/day**
- **K:** 3-4 g/day
- **Phosphorus:** <1200mg/d;
- **No Fluid Restriction**
- Ferritin lab is low thus need IV iron supplement
- Multivitamin: Dialyvite

Intervention: Goals

- Phosphorus, Protein, Calcium, Potassium Balance will vary
  - Monitor Protein Markers
- Increasing PA
  - Such as walking to mailboxes instead of driving to each individual one at work
  - Monitor weight gain

Intervention: Sample Diet

- **Breakfast:**
  - 2 scrambled eggs
  - ½ c strawberries,
  - 1 c OJ
  - 1 slice of whole wheat bread
  - 1 TBS peanut butter
  - **Total Kcal (507) and Protein (24 grams)**
- **Lunch:**
  - Chicken salad sandwich
  - 4-5 oz, ½ cup cucumber
  - ½ cup cauliflower
  - 2 TBS ranch
  - ½ cup canned pear
  - **Total Kcal (571) and Protein (20 grams)**

Intervention: Sample Diet

- **Dinner:** 4 oz Grilled lamb
  - 1/2 cup canned green beans
  - ½ cup brown rice
  - 1 whole wheat dinner roll
  - **Total Kcal (429) and Protein (55 g)**
- **HS:**
  - ½ cup grapes
  - Boost High Calorie
  - **Total Kcal (242) and Protein (17 g)**
- 400 kcal from PD
- **Total 2165 kcal, 101 g protein**