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Chemistry Review

Case Study #1

- A 42-year old male presents with anorexia, nausea, fever and icterus of the skin and mucous membranes. He noticed that his urine had appeared dark for the past several days. The physician orders a series of tests. Based on the following test results, what is the most likely diagnosis?
  - ALP: 240 U/L (36-92 U/L) AST: 1500 U/L (0-35 U/L)
  - GGT: 75 U/L (0-30 U/L) Total bilirubin: 1.9 mg/dL (0.-1.2 gm/dL)
  - Urine bilirubin: positive Fecal urobilinogen: decreased

  - A. Acute hepatitis
  - B. Alcoholic cirrhosis
  - C. Metastatic carcinoma of the pancreas
  - D. Obstructive jaundice

- AST (0-35 U/L)
  - will be very elevated in liver disease; Maybe 100 x normal with viral hepatitis
  - Used to diagnose and monitor hepatocellular disease
- GGT (0-30 U/L)
  - Very elevated in obstructive disease (hepatobilliary)
  - Moderate increase in hepatocellular
  - ALP + GGT are increased = Liver NOT bone
- ALP (36-92 U/L)
  - Moderate Increase (3x normal) with extra hepatobiliary disease
  - Biliary obstruction causes synthesis of ALP so will be very increased
- Bilirubin (Total 0.3-1.2 mg/dL; direct 0-0.3 mg/dL)
  - Must pass through liver to be conjugated (water soluble)= direct bilirubin
  - Direct → bile duct → gall bladder → duodenum → bacteria reduce to urobilinogen → excreted in feces
- Urobilinogen (Fecal)
  - Decreased (chalk-clay color to feces) amounts indicate liver obstruction or liver disease

Case Study # 2

- A 4-year old male child is brought to the pediatrician because the parents are concerned about the child's frequent falling, which results in bruising. The parents indicate that the child has difficulty running, walking, standing up, climbing stairs, and even sitting up straight. The child also appears somewhat weak. Which enzyme(s) would you expect to be elevated?
  - A. AST ⬅ B. ALP
  - C. LD ⬅ D. CK ⬅
  - What diagnosis would you expect?
    - Duchene's Muscular Dystrophy

- Duchene's Muscular Dystrophy
  - Muscle weakness due to destruction of muscle fibers
  - X-linked recessive disorder, symptoms start in males 3-7 yrs old
  - CK
    - 50-100X normal. Indicates muscle destruction
  - AST & LD
    - Increased because they are found in skeletal muscle
  - ALP
    - Not present in skeletal muscle
    - Used to assess hepatobiliary and bone disorders

Case Study #3

- A healthy active 10-year old boy with no prior history of illness comes to the lab after school for a routine chemistry screen in order to meet requirements for summer camp. After centrifugation, the serum looks cloudy. The specimen had the following results
  - Blood glucose: 135 mg/dL (70-100 mg/dL)
  - Total cholesterol: 195 mg/dL ((150-199 mg/dL)
  - Triglyceride: 185 mg/dL (<250 mg/dL)
- What would be the most probable explanation
  - A. Risk for coronary artery disease
  - B. Has Type 1 Diabetes mellitus that is undiagnosed
  - C. Has an inherited genetic disease causing lipid imbalance
  - D. Was most likely not fasting when the specimen was drawn

- This is a 10 year-old healthy child. He is probably not suffering from any lipid disorder or glucose disorder.
  - Lipids were within high normal range
  - Glucose was elevated, but if from a non-fasting (random) specimen was within an acceptable range
    - Should never be >200 mg/dL
- Since he came directly from school, he was probably not fasting.

Case Study #4

- A 68-year old male in an unconscious state is transported to the emergency department after being involved in a one-car crash, where he drove off the road and hit a tree. Because he was alone at the time and there was no apparent cause for the accident, it is assumed that he blacked out, which caused him to lose control of the car. He was not wearing a seat belt and has a broken leg, multiple contusions, and cuts. Blood samples were drawn upon arrival to the ED and in 3-hr intervals for 12 hours; all control values were within acceptable range. Selected test results follow:

Test	Initial Values	3 Hours	9 Hours	Reference Ranges
Myoglobin	57 ng/mL	140 ng/mL	281 ng/mL	30-90 ng/mL
Total CK	112 U/L	170 U/L	390 U/L	15-160 U/L
CK-MB	3 ng/mL	6 ng/mL	8 ng/mL	0-5 ng/mL
Troponin I	0.10 ng/mL	0.12 ng/mL	0.11 ng/mL	<0.40 ng/mL

What do these test results suggest?

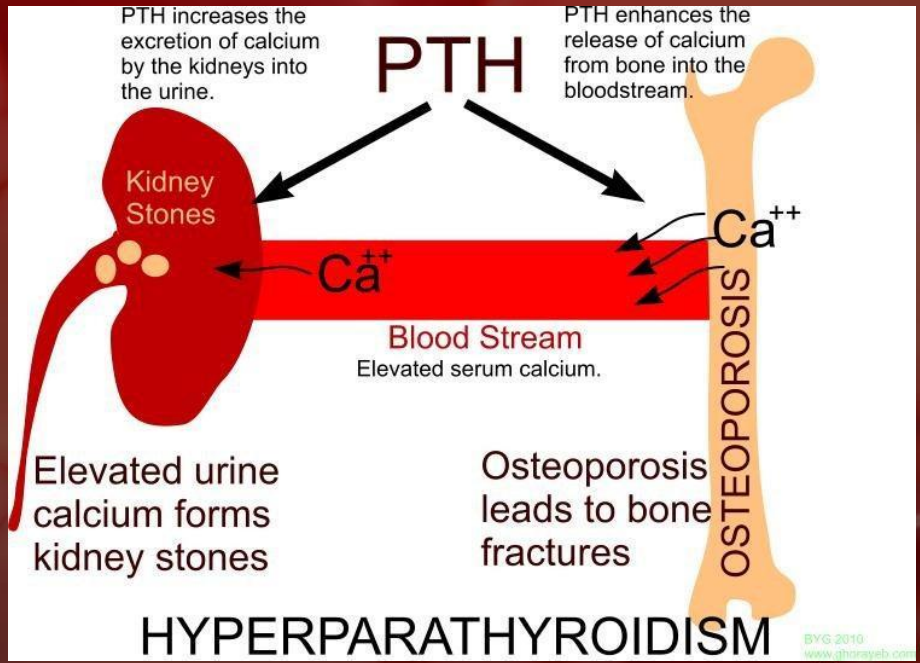
A. The man had a myocardial infarction, which caused the accident
B. The elevated results are from the skeletal muscle injuries sustained in the car crash
C. The elevated results are a combination of the car crash injuries and a myocardial infarction
D. The elevated total CK and CK-MB results indicate that the man had a stroke

- Troponin
  - No change indicates results due to muscle injury from car crash
  - Marker of choice for AMI
  - During AMI will increase at 4-6 hours post muscle damage; will remain increased 10-14 days
- CK & Myoglobin
  - Not tissue specific; will increase with any muscle damage
  - Myoglobin is negative indicator of AMI. If remains normal for 2-6 hour period then no muscle (cardiac or skeletal) injury has occurred
- CK-MB
  - Not tissue specific; will increase with any muscle damage

Case Study #5

- The following laboratory results were obtained on a 60-year old woman who is complaining of anorexia, constipation, abdominal pain, nausea and vomiting
  - Ionized serum calcium: 11.2 mg/dL(9-10.5 mg/dL)
  - Serum inorganic phosphate: 2.5 mg/dL(3-4.5 mg/dL)
  - Urine calcium: 420 mg/24 hr(100-300 mg/24hr)
  - Urine phosphate: 2.0 g/24 hrs (0.4-1.3 g/24 hrs)
  - What do these results suggest?
    - A. Primary hyperparathyroidism
    - B. Vitamin D deficiency
    - C. Hypoparathyroidism
    - D. Paget disease

- Primary hyperparathyroidism causes PTH to be produced without the stimulus of the parathyroid , usually caused by a single adenoma
- PTH: Parathyroid Hormone is stimulated by decreased calcium ion
  - Increased PTH = Increased Ca and Vit D_3, and decreased PO_4
  - PTH causes kidneys to decrease reabsorption of PO_4 and increase renal synthesis of Vit D_3



Case Study #6

- A patient's serum inorganic phosphate level is found to be elevated but the physician cannot determine a physiological basis for this abnormal result. What could possibly have caused an erroneous result to be reported?
  - A. Patient not fasting when blood was drawn
  - B. Specimen was hemolyzed
  - C. Effect of diurnal variation
  - D. Patient receiving intravenous glucose therapy

- PO_4 is a major intracellular anion
- Hemolysis should be avoided
  - Components affected by hemolysis
    - Increases
      - Ammonia, Total protein, iron, phosphate, potassium, magnesium, ALT, AST, CK, LD, ALP, ACP, Cholesterol, Triglyceride, catecholamines
    - Decreases
      - Albumin, bilirubin, sodium,
- Remove from clot ASAP to avoid leakage of PO_4 into serum
- Decreased PO_4 levels seen
  - Following meals, menstrual period, IV glucose and fructose therapy

Case Study #7

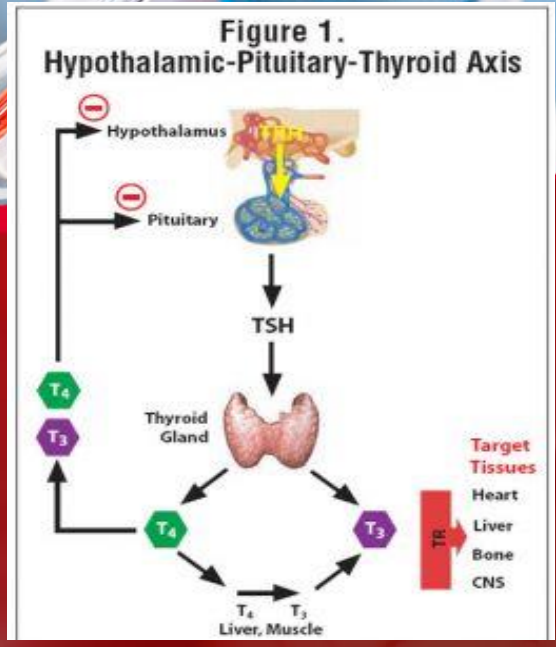
- A 30-year old woman is admitted to the hospital. She has truncal obesity, buffalo humpback, moon face, purple striae, hypertension, hyperglycemia, increased facial hair, acne, and amenorrhea. The physician orders endocrine testing. The results are
  - Urine free cortisol: increased
  - Serum cortisol (8 a.m.) Increased
  - Plasma ACTH: decreased
  - Dexamethasone suppression test:
    - Overnight low dose: no suppression of serum cortisol
    - High dose: no suppression of serum cortisol
  - What is the most probable diagnosis?
    - A. Pituitary adenoma
    - B. Ectopic ACTH lung cancer
    - C. Adrenocortical carcinoma
    - D. Addison disease

- Diagnosis: Cushing's syndrome by Adrenocortical carcinoma
  - Increased urine and serum Cortisol
  - Decreased ACTH due to negative feedback of cortisol
    - ACTH: stimulates synthesis of glucocorticoid compounds (cortisol) by adrenal cortex
    - Normal secretion of cortisol follows a diurnal pattern
  - Carcinoma produces excess cortisol that Dexamethasone cannot suppress
  - Physical symptoms: moon face, truncal obesity with buffalo hump, occasional hirsutism
- **Be careful!!** There is a Cushing's syndrome by adrenocortical carcinoma and a Cushing's syndrome by pituitary (Cushing's disease). Both show increased cortisol, but pituitary will also have increased ACTH
- Other choices
  - Pituitary adenoma or ectopic ACTH lung cancer :Increased ACTH levels
  - Addison's: Hypofunction of adrenal cortex

Case Study #8

- In a patient with suspected primary hyperthyroidism associated with Graves disease, one would expect the following laboratory serum results:
- (use increased and decreased)
- Free thyroxine (FT_4_____, thyroid hormone binding ratio (THBR) _____and thyroid-stimulating hormone (TSH) _____

- Free thyroxine: Increased
- Thyroid hormone binding ratio: Increased
- Thyroid-stimulating hormone: Decreased



- Graves disease
  - Hyperactive thyroid producing thyrotoxicosis
    - Thyrotoxicosis is a term used to describe a condition that occurs when excessive amounts of thyroid hormones in circulation affect peripheral tissue.
  - FT_4 & FT_3 are increased
  - THBR is increased due to increased T_3 binding to TBG
  - TSH is decreased because normal feedback mechanism is working
  - Occurs more often in women, typical onset 30-50 yrs in age
  - Does not respond to normal feedback mechanism of T_4 so thyroid continues to produce hormones

Case Study #9

- A 53-year old female presents with fatigue, pruritus (itch), and an enlarged, non-tender liver. The physician orders a series of blood tests. Based on the following serum test results, what is the most likely diagnosis?
  - ALP: 358 U/L (36-92 U/L) AST: 42 U/L(0-35 U/L)
  - LD: 120 U/L(60-100 U/L) GGT: 126 U/L (0-30 U/L)
  - Total Bilirubin: 1.6 mg/dL (0.3-1.2 mg/dL)

  - A. Alcoholic cirrhosis
  - B. Infectious mononucleosis
  - C. Intrahepatic cholestasis
  - D. Viral hepatitis

- Intrahepatic cholestasis means biliary tree obstruction
- ALP (36-92 U/L)
  - Biliary obstruction causes synthesis of ALP so markedly increased
  - In the other disease choices, ALP would be only slightly increased
- GGT (0-30 U/L)
  - Marked elevation (5-30x normal) in hepatic obstruction
  - ALP + GGT increased = Liver
- AST, ALT, LD (AST 0-35 U/L; ALT (0-35 U/L); LD (60-100 U/L)
  - AST marked increase with hepatocellular disease
  - ALT marked increase with hepatocellular disease
  - LD increases with any tissue injury
- Total Bilirubin (0.3-1.2 mg/dL)
  - Early in disease will remain normal or slightly increased

Case Study #10

- A mother brings her obese 4-year old child who is a known type 1 diabetic to the laboratory for a blood work up. She states that the boy has been fasting for the past 12 hours. After centrifugation the tech notes that the serum looks turbid. The specimen had the following results
  - Blood glucose: 150 mg/dL (70-100 mg/dL)
  - Total cholesterol: 250 g/dL (150-199 mg/dL)
  - HDL cholesterol: 32 mg/dL (>40 mg/dL)
  - Triglyceride: 395 mg/dL (<250 mg/dL)
- what best explains these findings?
  - A. Is a low risk for coronary artery disease
  - B. Is a good candidate for a 3-hour oral glucose tolerance test
  - C. Has secondary hyperlipidemia due to the diabetes
  - D. Was not fasting when the specimen was drawn

- Fits description of secondary hyperlipidemia
  - Secondary to Diabetes mellitus
    - Hyperlipidemia prevalent in childhood
  - Inability to utilize glucose causes release of fatty acids
- Known diabetics should NEVER undergo 3hr OGTT
- High risk for CAD

Case Study #11

- A 46-year old known alcoholic with liver damage is brought into the emergency department unconscious. In what way would you expect his plasma lipid values to be affected?

  - A. Increased total cholesterol, triglyceride, LDL and VLDL
  - B. Increased total cholesterol and triglyceride, decreased LDL and VLDL
  - C. Decreased total cholesterol, triglyceride, LD and VLDL
  - D. Normal lipid metabolism, unaffected by the alcoholism

- Liver damage due to alcohol use can make it inefficient in metabolizing fats.
  - Increase in total cholesterol, triglycerides, LDL and/or VLDL in blood
  - Poor prognosis for the patient
- Liver is unable to oxidize the fatty acids (β-oxidation) to acetyl Co A due to the lack of NAD. This causes a build up of fat in the liver.
- NAD is used to metabolize alcohol so it is not available for β-oxidation

Case Study 12

- A 10-year old female presents with varicella (chicken pox). The child has been experiencing fever, nausea, vomiting, lethargy and disorientation. A diagnosis of Reye syndrome is determined. Which of the following is not consistent with this diagnosis?

  - A. AST: 50 U/L (0-35 U/L)
  - B. ALT: 112 U/L (0-35 U/L)
  - C. Ammonia (Plasma): 98 µg/L (40-80 µg/L)
  - D. Total bilirubin: 1.8 mg/dL (0.3-1.2 mg/dL)

- Reye's syndrome is associated with viral infection, toxins and aspirin use
- Usually seen in children 2-13 years of age
- Encephalopathy and fatty degeneration of the liver are hallmarks
- AST
  - Slightly increased; markedly elevated in hepatocellular disease
- ALT
  - Markedly increased in hepatocellular disorders that are viral
- Ammonia
  - Increased due to inability of liver to convert to Urea
  - Elevated in advanced liver disease and renal failure
  - Can be toxic to patient causing seizures and coma
- PT
  - Will increase with Reye's syndrome
- Bilirubin
  - Usually remains normal

Case Study #13

- A 23-year old woman with a history of asthma was brought to the emergency department by ambulance. She was extremely short of breath. Her level of consciousness was diminished greatly, and she was only able to respond to questions with nods or one word responses. She had a weak cough, with nearly inaudible breath sounds. After drawing blood gases, she was placed on supplemental oxygen.

Arterial Blood gases		
	Patient	Reference Range
pH	7.330	7.35-7.45
pCO_2	25 mm Hg	35-45 mmHg
pO_2	58 mmHg	80-110 mm Hg
HCO_3^-	13 mmol/L	22-26 mmol/L
tHb	12.4 g/L	12-16 g/dL

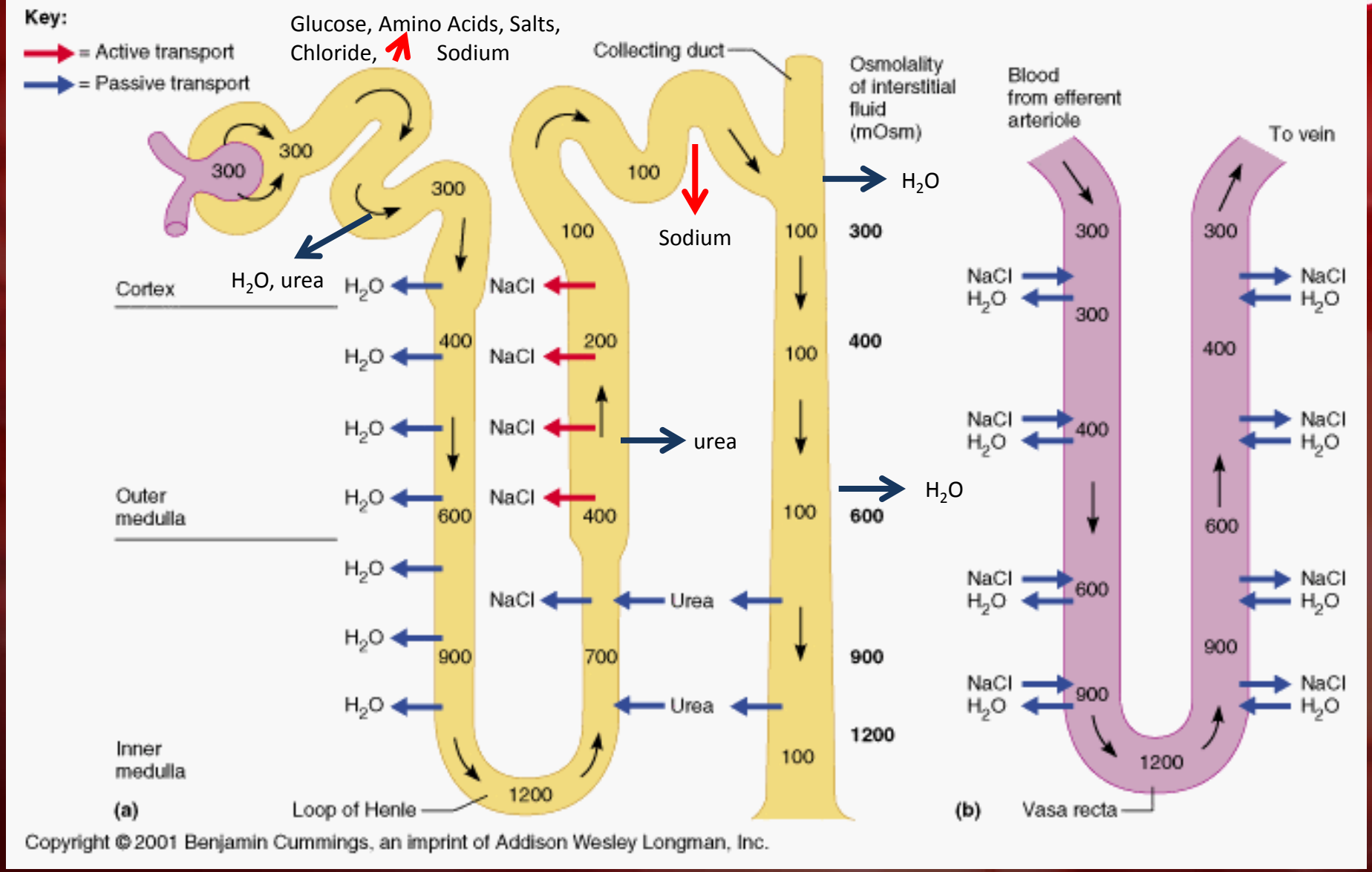
- What is this patient's acid-base status?
  - A. Uncompensated respiratory acidosis
  - B. Compensated metabolic acidosis
  - C. Partially compensated metabolic acidosis

- **Uncompensated**: initial parameter and pH are affected
- **Partially compensated:** all parameters are increased or decreased
- **Fully compensated** :pH is back to normal, **but** pH is only parameter in the normal range
- Respiratory: pCO_2 parameter initially affected
- Metabolic: HCO_3^- parameter initially affected

Case Study # 14

- Which of the following disorders is best characterized by laboratory findings that include increased serum levels of inorganic phosphorus, magnesium, potassium, uric acid, urea and creatinine and decreased serum calcium and erythropoietin levels?
  - A. Chronic renal failure
  - B. Renal tubular disease
  - C. Nephrotic syndrome
  - D. Acute glomerulonephritis

- Acute glomerulonephritis
  - Urine will show blood, protein and casts (RBC)
  - May be seen post Strep. infection
  - Increase in BUN but will return to normal
- Nephrotic syndrome
  - Increase in lipids, decrease in serum albumin and large in crease in urine protein
- Renal Tubular disease
  - Override of tubular reabsorption
- CRF
  - loss of excretory function of the kidneys
  - Inability to regulate water and electrolyte balance
  - Increase in parathyroid hormone (PTH)
  - Decrease in erythropoietin will cause anemia to develop



Case Study #15

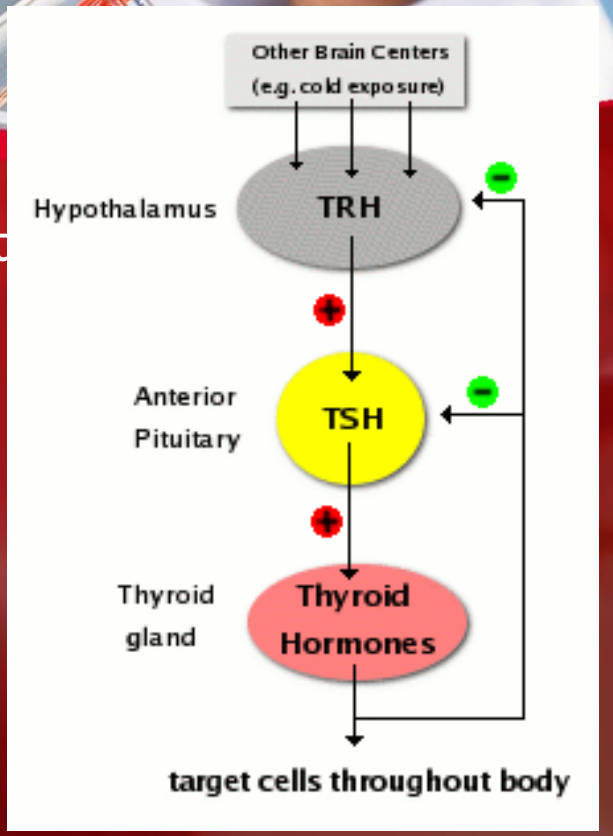
- An 8-year old boy comes to see his family physician with his mother. He has been urinating excessively and also has been drinking an excessive quantity of water. He recently recovered from an upper respiratory viral infection and has lost weight since his last visit. The following lab results were reported

Blood		Urinalysis	
FBG	300 mg/dL	Sp gravity	1.025
WBC count	15 x 10^9/L	Glucose	550 mg/dL
Hemoglobin	14.0 g/dL	Ketones	Moderate

- What lab test should be ordered to aid in the diagnosis of this patient?
  - A. 3-hr OGTT
  - B. β-cell autoantibodies
  - C. 2-hr PP glucose
  - D. Insulin receptor autoantibodies

Case Study #16

- A 2-year-old child with a decreased serum T_4 is described as being somewhat dwarfed, stocky, overweight, and having coarse features. Of the following, the most informative additional laboratory test would be the serum:
  - A. Thyroxine-binding globulin (TBG)
  - B. Thyroid-stimulating hormone (TSH)
  - C. Triiodothyronine (T_3)
  - D. Thyroid –regulating hormone (TRH)



- TRH: Produced by hypothalamus in response t to need for T_3 and T_4 in the blood stream
  - Stress, temperature, low levels
- TSH: Pituitary hormone that stimulates the thyroid to secrete thyroid hormone
- T_4: Prohormone
  - Almost 100% found bound to protein (TBG, TBPA, Albumin)
- T_3: Most potent of thyroid hormones, Secreted in lesser amounts than T_4
  - 20% from direct secretion, 80% from removal of iodine from T_4
    - Occurs mainly in liver and kidney
- TBG: Binds most of T_4 and majority of T_3
  - Provides constant supply of thyroid hormone (acts as reservoir)

Case Study # 17

- A 54-year old female arrived at her physician's office with complaints of lethargy, excessive thirst and diminished appetite. The lab results indicate a calcium value of 12.0 mg/dL, albumin <1.0 g/dL, total protein 10.9 g/dL, globulins ***, and increased BUN and Creatinine. What is her most probable diagnosis?
  - A. Multiple Myeloma
  - B. Dehydration
  - C. Primary hyperparathyroidism
  - D. Congestive Heart Failure

- Multiple Myeloma
  - Common in people over 60 yrs old
  - Increase in one immunoglobulin (IgG or IgA) with decrease in all other proteins. May see Bence Jones proteins in urine, Increase in calcium due to bone lesions
- Dehydration
  - Increase in proteins is relative to water loss through vascular system
- Primary hyperparathyroidism
  - Most common cause of increased calcium
  - Over production of PTH due to adenoma parathyroid gland
- Congestive Heart Failure
  - Leading cause of hospitalization in 65yrs and older
  - Key test is BNP, indicates sustained stretch
  - Increased blood volume would have decreased total protein

Case Study # 18

- An 80 year old man with a history of chronic obstructive pulmonary disease (COPD) and respiratory infections, was admitted through the ER with a chronic cough and extreme dyspnea (extreme respiratory distress). He complained that he was unable to climb stairs or anything else that required any exertion (even washing his hair). He had been a heavy smoker but had been attempting to stop smoking by cutting back on the number of cigarettes per day. The nurse noted his temperature was 101.2°F.

Arterial Blood Gas on Admission		
	Patient	Reference Range
pH	7.230	7.35-7.45
PCO_2	75.0 mmHg	35-45 mmHg
PO_2	28.2 mmHg	83-108 mmHg
HCO_3	32.7 mEq/L	22-28 mEq/L
SaO_2	49.6 %	95-98%

- What condition does this patient have?
  - A. Compensated respiratory acidosis
  - B. Uncompensated respiratory acidosis
  - C. Partially Compensated respiratory acidosis ⬅
  - D. Compensated metabolic acidosis
  - E. Uncompensated metabolic acidosis
  - F. Partially Compensated metabolic acidosis

  - Patient is in acidosis shown by the pH being lower (more acidic) than normal.
  - Respiratory acidosis is characterized by decreased pH, increased pCO_2, and normal HCO_3^- (if compensated)
    - Primary compensatory mechanism is to increase HCO_3^-
    - Kidney provides primary compensatory mechanism: increase excretion of acids, retain sodium and bicarbonate, increase production of renal ammonia
    - Hyperventilation may occur is lungs are working properly: increase PCO_2
  - Metabolic acidosis is characterized by decreased pH and HCO_3^- and normal PCO_2

- Six hours later, the patient had ABGs drawn with the following results

ABG Results 6 hours postadmission		
pH	7.38	7.35-7.45
pCO_2	60.0 mmHg	35-45 mmHg
PO_2	78.2 mmHg	83-108 mmHg
HCO_3^-	36.2mEq/L	22-28 mEq/L
SaO_2	90.6 %	95-98%

- The patient's status is now
  - A. Compensated respiratory acidosis
  - B. Uncompensated respiratory acidosis
  - C. Compensated metabolic acidosis
  - D. Uncompensated metabolic acidosis

Case Study #19

- A 55 year old female reported for her annual physical examination and had comprehensive blood work drawn. On the examination, the physician noted that she had the beginning of Osteopenia. Her lab work revealed a low normal ionized calcium, normal electrolytes, glucose, BUN and creatinine.
- What therapies would be suggested?
  - A. Calcium supplements
  - B. Calcium and vitamin D supplements
  - C. Calcium and phosphorus supplements
  - D. No therapy is required

- Osteopenia:
  - Decreased bone mass due to imbalance between bone resorption and formation
- Osteoporosis:
  - Most prevalent metabolic bone disease in adults, more common in women causing skeletal fragility
  - Decreased bone density measured using spine and hip
- Best to prevent with adequate nutrition including calcium and vitamin D and exercise

Case Study #20

- A 21 year old male went to his physician with complaints of tender joints following a weekend trip to the beach. His lab results follow,

- Which result(s) are concerning?
  - A. Globulin
  - B. BUN:Creat
  - C. Cholesterol
  - D. Sodium

Chemistry

- GLU 112 74-143 mg/dL
- BUN 13 7-27 md/dL
- CREA 1.5 0.5-1.8 mg/dL
- TP 7.8 5.2-8.2 g/dL
- ALB 3.2 2.3-4.0 g/dL
- GLOB 4.6 * 2.5-4.5 g/dL
- TBIL 0.3 0.0-0.9 mg/dL
- CHOL 211 110-320 mg/dL
- Na >180 * 144-160 mmol/L
- K 4.8 3.5-5.8 mmol/L
- CL 119 109-122 mmol/L

CBC

- RBC 8.29 5.65-8.87 M/µL
- HCT 53.5 37.3-61.7%
- HGB 19.3 13.1-20.5 g/dL
- MCV 64.5 61.6-73.5 fL
- MCH 23.3 21.2-25.9 pg
- MCHC 36.1 32.0-37.9 g/dL
- RDW 19.4 13.6-21.7 %
- WBC 9.68 5.05-16.76 K/µL
- PLT 190 148-484 K/µL
- MPV 12.3 8.7-13.2 fL

- Globulins
  - Increased to 4.6 g/dL with a normal total protein
  - Increase in liver disease, infections, myeloma, parasitic disease and rheumatic disorders
- BUN:Creatinine ratio is 9:1 (Normal 10:1-20:1)
  - Pre-Renal: Increase BUN normal Creatinine; increased BUN:Creat
  - Renal: Low BUN:Creat, associated with low protein intake, acute tubular necrosis, severe liver disease
  - Post-Renal: Elevated BUN and Creatinine; increased BUN:Creat
- Cholesterol (Normal 140-200 mg/dL), May not be fasting
- Sodium
  - Hypernatremia: Excessive water loss relative to sodium loss
    - Can be caused by any condition where there is an increase in water loss: Fever, burns, diarrhea, heat exposure
  - Evaluate with osmolality (increased)
  - >160 mmol/L associated with 60-75% mortality rate

- Osmolality
  - Measure of dissolved solutes in a solution
  - Use osmotically active substances: Na, BUN, Glucose
  - Two equations
  - $2\ Na + \frac{glucose\ (\frac{mg}{dL})}{20} + \frac{BUN\ (\frac{mg}{dL})}{3}$
  - $1.86\ Na + \frac{glucose\ (\frac{mg}{dL})}{18} + \frac{BUN}{2.8} + 9$
  - Osmolality= 355-370 mOsmol

Case Study #21

- A 52 year old man came to the ED following his last chemotherapy session. To celebrate the last chemotherapy he had gone out to dinner and had all of his favorite foods. He was now feeling nauseous, weak and dizzy.
- The physician ordered a chemistry panel and CBC
- What is the probable diagnosis?
  - A. Anemia
  - B. Metabolic Acidosis
  - C. Hepatic biliary obstruction
  - D. Uremia
  - E. Celebration

Chemistry

- Na 139 136-145 mEq/L
- K 4.2 3.6-5.0 mEq/L
- Cl 104 101-111 mEq/L
- CO_2 27.0 24.0-34.0 mEq/L
- Glu 100 80-120 mg/dL
- TBIL 0.3 0.2-1.2 mg/dL
- Tpro 6.5 6.0-8.4 g/dL
- BUN 20 7-24 mg/dL
- Creat 0.9 0.5-1.2 mg/dL
- Uric Acid 11.5 3.5-5.2 mg/dL
- Alb 3.6 3.5-5.0 g/dL

CBC

- WBC 15.0 5-10 x 10^9/L
- RBC 5.04 5-6 x 10^{12}/L
- Hb 153 135-175 g/L
- Hct 0.4 0.41-0.53 L/L
- MCV 92 80-100 fL
- MCH 29 26-34 pg
- MCHC 33 31-37 %
- Plts 240 150-400 x 10^9/L

- Anemia
  - Normal RBC, Hemoglobin and hematocrit
  - Watch the units!
- Metabolic acidosis
  - Decrease in pH not noted, CO_2 normal (bicarbonate)
  - Bicarb and CO_2
- Obstruction
  - Liver enzymes: AST and ALP are normal
- Uremia
  - DNA = Increased uric acid
  - Chemo caused increased uric acid
  - Urea cycle→ purines
  - Gout
- What foods may have contributed to the increased uric acid?
- Renal complications?

- Content of single high protein meal has minimal effect on urea, so fasting is not required
- Urea used by bacteria, urine must be tested ASAP
- Increased urea is azotemia
  - Uremia is highly increased plasma urea with renal failure. Eventually fatal if not treated by dialysis or transplant.
- Conditions causing increased plasma urea
  - Prerenal: Reduced renal blood flow
  - Renal: Decreased renal function, compromised urea excretion
  - Postrenal: obstruction
- BUN:Creat ratio
  - Difference caused by abnormal urea concentration
  - Normal 10:1-20:1

Case Study #22

- Laboratory tests are performed on a postmenopausal, 57-year old female as part of an annual physical examination. The patient's casual plasma glucose is 220 mg/dL, and the glycated hemoglobin (HbA1c) is 11%. Based on this information, how should the patient be classified?
  - A. Normal glucose tolerance
  - B. Impaired glucose tolerance
  - C. Gestational diabetes mellitus
  - D. Type 2 diabetes mellitus

Classification	Lab value
Hypoglycemia	FBG < 40mg/dL
Normal fasting glucose	FPG < 100 mg/dL
Normal Glucose Tolerance	2hr PG <140 mg/dL
Increased risk for diabetes	A1C = 5.7-6.1%
Impaired fasting glucose	FPG ≥100 mg/dl ≤ 125 mg/dL
Impaired glucose tolerance	2hr PG ≥140 mg/dL ≤199 mg/dL
Diabetes mellitus	Random glucose > 200 mg/dL with hyperglycemic symptoms
	OGTT > 200 mg/dL

- "Normal" random glucose should be <200 mg/dL
- $HbA1_c$ reference range is 4-6%
- Probable diagnosis is Type 2 Diabetes mellitus.
  - In absence of any hyperglycemic symptoms, the glucose and $HbA1_c$ should be repeated on another day, using a fasting sample

References

- 1. Graves, L.(2002) *Case Studies in Clinical Laboratory Science*. Upper Saddle River, NJ: Prentice Hall
- 2. Bishop, M. L., Fody, E. P., Schoeff, L.E (2013). *Clinical Chemistry: Principles, Techniques, and Correlations*. 7th ed. Philadelphia: Lippincott.
- 3. Burtis, C. A., Ashwood, E. R., Bruns, D.E. (2008). *Tietz fundamentals of clinical chemistry*. Philadelphia: W.B. Saunders.
- 4. Harr, R. (2007). *Clinical Laboratory Science Review*. 3rd ed. Philadelphia: F.A. Davis Company.
- 5. Castleberry, B.M., Lunz, M. E., Sahl, B.L. (1996). *Board of Registry Study Guide, Clinical Laboratory Certification Examinations.* 4th ed. American Society for Clinical Pathology: Chicago