Carbohydrates

1. Following overnight fasting, hypoglycemia in adults is defined as a glucose of:
   a. ≤70 mg/dL (≤3.9 mmol/L)
   b. ≤60 mg/dL (≤3.3 mmol/L)
   c. ≤55 mg/dL (≤3.0 mmol/L)
   d. ≤45 mg/dL (≤2.5 mmol/L)

2. The following results are from a 21-year-old patient with a back injury who appears otherwise healthy:
   - Whole blood glucose: 77 mg/dL (4.2 mmol/L)
   - Serum glucose: 88 mg/dL (4.8 mmol/L)
   - CSF glucose: 56 mg/dL (3.1 mmol/L)

   The best interpretation of these results is that:
   a. the whole blood and serum values are expected but the CSF value is elevated
   b. the whole blood glucose value should be higher than the serum value
   c. all values are consistent with a normal healthy individual
   d. the serum and whole blood values should be identical

3. The preparation of a patient for standard glucose tolerance testing should include:
   a. a high carbohydrate diet for 3 days
   b. a low carbohydrate diet for 3 days
   c. fasting for 48 hours prior to testing
   d. bed rest for 3 days
4. If a fasting glucose was 90 mg/dL, which of the following 2-hour postprandial glucose results would most closely represent normal glucose metabolism?
   a. 55 mg/dL (3.0 mmol/L)
   b. 100 mg/dL (5.5 mmol/L)
   c. 180 mg/dL (9.9 mmol/L)
   d. 260 mg/dL (14.3 mmol/L)

5. A healthy person with a blood glucose of 80 mg/dL (4.4 mmol/L) would have a simultaneously determined cerebrospinal fluid glucose value of:
   a. 25 mg/dL (1.4 mmol/L)
   b. 50 mg/dL (2.3 mmol/L)
   c. 100 mg/dL (5.5 mmol/L)
   d. 150 mg/dL (8.3 mmol/L)

6. A 25-year-old man became nauseated and vomited 90 minutes after receiving a standard 75 g carbohydrate dose for an oral glucose tolerance test. The best course of action is to:
   a. give the patient a glass of orange juice and continue the test
   b. start the test over immediately with a 50 g carbohydrate dose
   c. draw blood for glucose and discontinue test
   d. place the patient in a recumbent position, reassure him and continue the test

7. Cerebrospinal fluid for glucose assay should be:
   a. refrigerated
   b. analyzed immediately
   c. heated to 56°C
   d. stored at room temperature after centrifugation

8. Which of the following 2-hour postprandial glucose values demonstrates unequivocal hyperglycemia diagnostic for diabetes mellitus?
   a. 160 mg/dL (8.8 mmol/L)
   b. 170 mg/dL (9.4 mmol/L)
   c. 180 mg/dL (9.9 mmol/L)
   d. 200 mg/dL (11.0 mmol/L)

9. Serum levels that define hypoglycemia in pre-term or low birth weight infants are:
   a. the same as adults
   b. lower than adults
   c. the same as a normal full-term infant
   d. higher than a normal full-term infant

10. A 45-year-old woman has a fasting serum glucose concentration of 95 mg/dL (5.2 mmol/L) and a 2-hour postprandial glucose concentration of 105 mg/dL (5.8 mmol/L). The statement which best describes this patient’s fasting serum glucose concentration is:
    a. normal; reflecting glycogen breakdown by the liver
    b. normal; reflecting glycogen breakdown by skeletal muscle
    c. abnormal; indicating diabetes mellitus
    d. abnormal; indicating hypoglycemia

11. Pregnant women with symptoms of thirst, frequent urination or unexplained weight loss should have which of the following tests performed?
    a. tolbutamide test
    b. lactose tolerance test
    c. epinephrine tolerance test
    d. glucose tolerance test
2: Chemistry | Carbohydrates

12. In the fasting state, the arterial and capillary blood glucose concentration varies from the venous glucose concentration by approximately how many mg/dL (mmol/L)?
   a. 1 mg/dL (0.05 mmol/L) higher
   b. 5 mg/dL (0.27 mmol/L) higher
   c. 10 mg/dL (0.55 mmol/L) lower
   d. 15 mg/dL (0.82 mmol/L) lower

13. The conversion of glucose or other hexoses into lactate or pyruvate is called:
   a. glycogenesis
   b. glycogenolysis
   c. gluconeogenesis
   d. glycolysis

14. Which one of the following values obtained during a glucose tolerance test are diagnostic of diabetes mellitus?
   a. 2-hour specimen = 150 mg/dL (8.3 mmol/L)
   b. fasting plasma glucose = 126 mg/dL (6.9 mmol/L)
   c. fasting plasma glucose = 110 mg/dL (6.1 mmol/L)
   d. 2-hour specimen = 180 mg/dL (9.9 mmol/L)

15. The glycated hemoglobin value represents the integrated values of glucose concentration during the preceding:
   a. 1-3 weeks
   b. 4-5 weeks
   c. 6-8 weeks
   d. 16-20 weeks

16. Monitoring long-term glucose control in patients with adult onset diabetes mellitus can best be accomplished by measuring:
   a. weekly fasting 7 AM serum glucose
   b. glucose tolerance testing
   c. 2-hour postprandial serum glucose
   d. hemoglobin A1c

17. A patient with Type I, insulin-dependent diabetes mellitus has the following results:

<table>
<thead>
<tr>
<th>Test</th>
<th>Patient</th>
<th>Reference Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>fasting blood glucose</td>
<td>150 mg/dL (8.3 mmol/L)</td>
<td>70-110 mg/dL (3.9-6.1 mmol/L)</td>
</tr>
<tr>
<td>hemoglobin A1c</td>
<td>8.5%</td>
<td>4.0%-6.0%</td>
</tr>
<tr>
<td>fructosamine</td>
<td>2.5 mmol/L</td>
<td>2.0-2.9 mmol/L</td>
</tr>
</tbody>
</table>

After reviewing these test results, the technologist concluded that the patient is in a:
   a. "steady state" of metabolic control
   b. state of flux, progressively worsening metabolic control
   c. improving state of metabolic control as indicated by fructosamine
   d. state of flux as indicated by the fasting glucose level

18. Total glycosylated hemoglobin levels in a hemolysate reflect the:
   a. average blood glucose levels of the past 2-3 months
   b. average blood glucose levels for the past week
   c. blood glucose level at the time the sample is drawn
   d. hemoglobin A1c level at the time the sample is drawn

19. Which of the following hemoglobins has glucose-6-phosphate on the amino-terminal valine of the beta chain?
   a. S
   b. C
   c. A2
   d. A1c
20. A patient with hemolytic anemia will:
   a. show a decrease in glycated Hgb value
   b. show an increase in glycated Hgb value
   c. show little or no change in glycated Hgb value
   d. demonstrate an elevated Hgb A₁c

21. In using ion-exchange chromatographic methods, falsely increased levels of Hgb A₁c might be demonstrated in the presence of:
   a. iron deficiency anemia
   b. pernicious anemia
   c. thalassemias
   d. Hgb S

22. An increase in serum acetone is indicative of a defect in the metabolism of:
   a. carbohydrates
   b. fat
   c. urea nitrogen
   d. uric acid

23. An infant with diarrhea is being evaluated for a carbohydrate intolerance. His stool yields a positive copper reduction test and a pH of 5.0. It should be concluded that:
   a. further tests are indicated
   b. results are inconsistent—repeat both tests
   c. the diarrhea is not due to carbohydrate intolerance
   d. the tests provided no useful information

24. Blood samples were collected at the beginning of an exercise class and after thirty minutes of aerobic activity. Which of the following would be most consistent with the post-exercise sample?
   a. normal lactic acid, low pyruvate
   b. low lactic acid, elevated pyruvate
   c. elevated lactic acid, low pyruvate
   d. elevated lactic acid, elevated pyruvate

25. What is the best method to diagnose lactase deficiency?
   a. H₂ breath test
   b. plasma aldolase level
   c. LDH level
   d. D-xylose test

Acid-Base Balance

26. The expected blood gas results for a patient in chronic renal failure would match the pattern of:
   a. metabolic acidosis
   b. respiratory acidosis
   c. metabolic alkalosis
   d. respiratory alkalosis

27. Severe diarrhea causes:
   a. metabolic acidosis
   b. metabolic alkalosis
   c. respiratory acidosis
   d. respiratory alkalosis

Questions
28 The following blood gas results were obtained:

- pH: 7.18
- PO₂: 86 mm Hg
- PCO₂: 60 mm Hg
- O₂ saturation: 92%
- HCO₃⁻: 7921 mEq/L (21 mmol/L)
- TCO₂: 23 mEq/L (23 mmol/L)
- base excess: -8.0 mEq/L (-8.0 mmol/L)

The patient's results are compatible with which of the following?

- fever
- uremia
- emphysema
- dehydration

29 Factors that contribute to a PCO₂ electrode requiring 60-120 seconds to reach equilibrium include the:

- diffusion characteristics of the membrane
- actual blood PO₂
- type of calibrating standard (ie, liquid or humidified gas)
- potential of the polarizing mercury cell

30 An emphysema patient suffering from fluid accumulation in the alveolar spaces is likely to be in what metabolic state?

- respiratory acidosis
- respiratory alkalosis
- metabolic acidosis
- metabolic alkalosis

31 At blood pH 7.40, what is the ratio of bicarbonate to carbonic acid?

- 15:1
- 20:1
- 25:1
- 30:1

32 The reference range for the pH of arterial blood measured at 37°C is:

- 7.28-7.34
- 7.33-7.37
- 7.35-7.45
- 7.45-7.50

33 A 68-year-old man arrives in the emergency room with a glucose level of 722 mg/dL (39.7 mmol/L) and serum acetone of 4+ undiluted. An arterial blood gas from this patient is likely to be:

- low pH
- high pH
- low PO₂
- high PO₂

34 A patient is admitted to the emergency room in a state of metabolic alkalosis. Which of the following would be consistent with this diagnosis?

- high TCO₂, increased HCO₃⁻
- low TCO₂, increased HCO₃⁻
- high TCO₂, decreased H₂CO₃
- low TCO₂, decreased H₂CO₃
35 A person suspected of having metabolic alkalosis would have which of the following laboratory findings?
   a CO₂ content and PCO₂ elevated, pH decreased
   b CO₂ content decreased and pH elevated
   c CO₂ content, PCO₂ and pH decreased
   d CO₂ content and pH elevated

36 Metabolic acidosis is described as a(n):
   a increase in CO₂ content and PCO₂ with a decreased pH
   b decrease in CO₂ content with an increased pH
   c increase in CO₂ with an increased pH
   d decrease in CO₂ content and PCO₂ with a decreased pH

37 Respiratory acidosis is described as a(n):
   a increase in CO₂ content and PCO₂ with a decreased pH
   b decrease in CO₂ content with an increased pH
   c increase in CO₂ content with an increased pH
   d decrease in CO₂ content and PCO₂ with a decreased pH

38 A common cause of respiratory alkalosis is:
   a vomiting
   b starvation
   c asthma
   d hyperventilation

39 Acidosis and alkalosis are best defined as fluctuations in blood pH and CO₂ content due to changes in:
   a Bohr effect
   b O₂ content
   c bicarbonate buffer
   d carbonic anhydrase

40 A blood gas sample was sent to the lab on ice, and a bubble was present in the syringe. The blood had been exposed to room air for at least 30 minutes. The following change in blood gases will occur:
   a CO₂ content increased/PCO₂ decreased
   b CO₂ content and PO₂ increased/pH increased
   c CO₂ content and PCO₂ decreased/pH decreased
   d PO₂ increased/HCO₃ decreased

41 The following laboratory results were obtained:
   
   **Serum electrolytes**
   sodium: 136 mEq/L (136 mmol/L)
   potassium: 4.4 mEq/L (4.4 mmol/L)
   chloride: 92 mEq/L (92 mmol/L)
   bicarbonate: 40 mEq/L (40 mmol/L)

   **Arterial blood**
   pH: 7.32
   PCO₂: 79 mm Hg

   These results are most compatible with:
   a respiratory alkalosis
   b respiratory acidosis
   c metabolic alkalosis
   d metabolic acidosis
2: Chemistry | Electrolytes

42 Select the test which evaluates renal tubular function.
   a  IVP
   b  creatinine clearance
   c  osmolarity
   d  microscopic urinalysis

43 A patient had the following serum results:
   Na⁺: 140 mEq/L (140 mmol/L)
   K⁺:  4.0 mEq/L (4.0 mmol/L)
   glucose: 95 mg/dL (5.2 mmol/L)
   BUN: 10 mg/dL (3.57 mmol/L)

Which osmolality is consistent with these results?
   a  188
   b  204
   c  270
   d  390

44 The degree to which the kidney concentrates the glomerular filtrate can be determined by:
   a  urine creatine
   b  serum creatinine
   c  creatinine clearance
   d  urine to serum osmolality ratio

45 Osmolal gap is the difference between:
   a  the ideal and real osmolality values
   b  calculated and measured osmolality values
   c  plasma and water osmolality values
   d  molality and molarity at 4°C

Electrolytes

46 The most important buffer pair in plasma is the:
   a  phosphate/biphosphate pair
   b  hemoglobin/imidazole pair
   c  bicarbonate/carbonic acid pair
   d  sulfate/bisulfate pair

47 Quantitation of Na⁺ and K⁺ by ion-selective electrode is the standard method because:
   a  dilution is required for flame photometry
   b  there is no lipoprotein interference
   c  of advances in electrochemistry
   d  of the absence of an internal standard

48 What battery of tests is most useful in evaluating an anion gap of 22 mEq/L (22 mmol/L)?
   a  Ca++, Mg++, PO₄⁻, and pH
   b  BUN, creatinine, salicylate and methanol
   c  AST, ALT, LD and amylase
   d  glucose, CK, myoglobin and cryoglobulin
A patient with myeloproliferative disorder has the following values:

- Hgb: 13 g/dL (130 mmol/L)
- Hct: 38%
- WBC: $30 \times 10^9/\mu L (30 \times 10^9/L)$
- platelets: $1000 \times 10^9/\mu L (1000 \times 10^9/L)$
- serum Na*: 140 mEq/L (140 mmol/L)
- serum K*: 7 mEq/L (7 mmol/L)

The serum K* should be confirmed by:
- repeat testing of the original serum
- testing freshly drawn serum
- testing heparinized plasma
- atomic absorption spectrometry

Most of the carbon dioxide present in blood is in the form of:
- dissolved CO₂
- carbonate
- bicarbonate ion
- carbonic acid

Serum “anion gap” is increased in patients with:
- renal tubular acidosis
- diabetic alkalosis
- metabolic acidosis due to diarrhea
- lactic acidosis

The anion gap is useful for quality control of laboratory results for:
- amino acids and proteins
- blood gas analyses
- sodium, potassium, chloride, and total CO₂
- calcium, phosphorus and magnesium

The buffering capacity of blood is maintained by a reversible exchange process between bicarbonate and:
- sodium
- potassium
- calcium
- chloride

In respiratory acidosis, a compensatory mechanism is the increase in:
- respiration rate
- ammonia formation
- blood PCO₂
- plasma bicarbonate concentration

Which of the following electrolytes is the chief plasma cation whose main function is maintaining osmotic pressure?
- chloride
- calcium
- potassium
- sodium

A potassium level of 6.8 mEq/L (6.8 mmol/L) is obtained. Before reporting the results, the first step the technologist should take is to:
- check the serum for hemolysis
- rerun the test
- check the age of the patient
- do nothing, simply report out the result
57 The solute that contributes the most to the total serum osmolality is:
   a glucose
   b sodium
   c chloride
   d urea

58 A sweat chloride result of 55 mEq/L (55 mmol/L) and a sweat sodium of 52 mEq/L (52 mmol/L) were obtained on a patient who has a history of respiratory problems. The best interpretation of these results is:
   a normal
   b normal sodium and an abnormal chloride test should be repeated
   c abnormal results
   d borderline results, the test should be repeated

59 Which of the following is true about direct ion selective electrodes for electrolytes?
   a whole blood specimens are acceptable
   b elevated lipids cause falsely decreased results
   c elevated proteins cause falsely decreased results
   d elevated platelets cause falsely increased results

60 Sodium determination by indirect ion selective electrode is falsely decreased by:
   a elevated chloride levels
   b elevated lipid levels
   c decreased protein levels
   d decreased albumin levels

61 A physician requested that electrolytes on a multiple myeloma patient specimen be run by direct ISE and not indirect ISE because:
   a excess protein binds Na in indirect ISE
   b Na is falsely increased by indirect ISE
   c Na is falsely decreased by indirect ISE
   d excess protein reacts with diluent in indirect ISE

62 Which percentage of total serum calcium is nondiffusible protein bound?
   a 80%-90%
   b 51%-60%
   c 40%-50%
   d 10%-30%

63 Calcium concentration in the serum is regulated by:
   a insulin
   b parathyroid hormone
   c thyroxine
   d vitamin C

64 The regulation of calcium and phosphorous metabolism is accomplished by which of the following glands?
   a thyroid
   b parathyroid
   c adrenal glands
   d pituitary
65 A patient has the following test results:
- increased serum calcium levels
- decreased serum phosphate levels
- increased levels of parathyroid hormone

This patient most likely has:
- a hyperparathyroidism
- b hypoparathyroidism
- c nephrosis
- d steatorrhea

66 A hospitalized patient is experiencing increased neuromuscular irritability (tetany). Which of the following tests should be ordered immediately?
- a calcium
- b phosphate
- c BUN
- d glucose

67 Which of the following is most likely to be ordered in addition to serum calcium to determine the cause of tetany?
- a magnesium
- b phosphate
- c sodium
- d vitamin D

68 A reciprocal relationship exists between:
- a sodium and potassium
- b calcium and phosphate
- c chloride and CO₂
- d calcium and magnesium

69 Fasting serum phosphate concentration is controlled primarily by the:
- a pancreas
- b skeleton
- c parathyroid glands
- d small intestine

70 A low concentration of serum phosphorus is commonly found in:
- a patients who are receiving carbohydrate hyperalimentation
- b chronic renal disease
- c hypoparathyroidism
- d patients with pituitary tumors

71 The following laboratory results were obtained:

<table>
<thead>
<tr>
<th></th>
<th>Calcium</th>
<th>Alkaline Phosphate</th>
<th>Alkaline Phosphatase</th>
</tr>
</thead>
<tbody>
<tr>
<td>serum:</td>
<td>increased</td>
<td>decreased</td>
<td>normal or increased</td>
</tr>
<tr>
<td>urine:</td>
<td>increased</td>
<td>increased</td>
<td></td>
</tr>
</tbody>
</table>

These results are most compatible with:
- a multiple myeloma
- b milk-alkali syndrome
- c sarcoidosis
- d primary hyperparathyroidism
Proteins and Other Nitrogen-Containing Compounds

72. The primary function of serum albumin in the peripheral blood is to:
   a. maintain colloidal osmotic pressure
   b. increase antibody production
   c. increase fibrinogen formation
   d. maintain blood viscosity

73. In a pleural effusion caused by *Streptococcus pneumoniae*, the protein value of the pleural fluid as compared to the serum value would probably be:
   a. decreased by 2
   b. decreased by \( \frac{1}{2} \)
   c. increased by \( \frac{1}{2} \)
   d. equal

74. The first step in analyzing a 24-hour urine specimen for quantitative urine protein is:
   a. subculture the urine for bacteria
   b. add the appropriate preservative
   c. screen for albumin using a dipstick
   d. measure the total volume

75. When performing a manual protein analysis on a xanthochromic spinal fluid, the technician should:
   a. perform the test as usual
   b. make a patient blank
   c. centrifuge the specimen
   d. dilute the specimen with deionized water

76. The direction in which albumin migrates (ie, toward anode or cathode) during electrophoretic separation of serum proteins, at \( \text{pH} \ 8.6 \), is determined by:
   a. the ionization of the amine groups, yielding a net positive charge
   b. the ionization of the carboxyl groups, yielding a net negative charge
   c. albumin acting as a zwitterion
   d. the density of the gel layer

77. The protein that has the highest dye-binding capacity is:
   a. albumin
   b. alpha globulin
   c. beta globulin
   d. gamma globulin
The serum protein electrophoresis pattern shown below was obtained on cellulose acetate at pH 8.6.

Identify the serum protein fraction on the left of the illustration.

- a. gamma globulin
- b. albumin
- c. alpha-1 globulin
- d. alpha-2 globulin

The biuret reaction for the analysis of serum protein depends on the number of:

- a. free amino groups
- b. free carboxyl groups
- c. peptide bonds
- d. tyrosine residues

In electrophoresis of proteins, when the sample is placed in an electric field connected to a buffer of pH 8.6, all of the proteins:

- a. have a positive charge
- b. have a negative charge
- c. are electrically neutral
- d. migrate toward the cathode

The relative migration rate of proteins on cellulose acetate is based on:

- a. molecular weight
- b. concentration
- c. ionic charge
- d. particle size

The cellulose acetate electrophoresis at pH 8.6 of serum proteins will show an order of migration beginning with the fastest migration as follows:

- a. albumin, alpha-1 globulin, alpha-2 globulin, beta globulin, gamma globulin
- b. alpha-1 globulin, alpha-2 globulin, beta globulin, gamma globulin, albumin
- c. albumin, alpha-2 globulin, alpha-1 globulin, beta globulin, gamma globulin
- d. gamma globulin, beta globulin, alpha-2 globulin, alpha-1 globulin, albumin

Which of the following amino acids is associated with sulfhydryl group?

- a. cysteine
- b. glycine
- c. serine
- d. tyrosine
Maple syrup urine disease is characterized by an increase in which of the following urinary amino acids?

- a phenylalanine
- b tyrosine
- c valine, leucine and isoleucine
- d cystine and cysteine

Increased serum albumin concentrations are seen in which of the following conditions?

- a nephrotic syndrome
- b acute hepatitis
- c chronic inflammation
- d dehydration

The following data was obtained from a cellulose acetate protein electrophoresis scan:

- albumin area: 75 units
- gamma globulin area: 30 units
- total area: 180 units
- total protein: 6.5 g/dL (65 g/L)

The gamma globulin content in g/dL is:

- a 1.1 g/dL (11 g/L)
- b 2.7 g/dL (27 g/L)
- c 3.8 g/dL (38 g/L)
- d 4.9 g/dL (49 g/L)

A patient is admitted with biliary cirrhosis. If a serum protein electrophoresis is performed, which of the following globulin fractions will be most elevated?

- a alpha-1
- b alpha-2
- c beta
- d gamma

Which of the following serum protein fractions is most likely to be elevated in patients with nephrotic syndrome?

- a alpha-1 globulin
- b albumin
- c alpha-2 globulin
- d beta globulin and gamma globulin
Refer to the following illustration:

<table>
<thead>
<tr>
<th>Patient values</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td>total protein</td>
<td>7.3 g/dL (73 g/L)</td>
</tr>
<tr>
<td>albumin</td>
<td>4.2 g/dL (42 g/L)</td>
</tr>
<tr>
<td>alpha-1</td>
<td>0.0 g/dL (0 g/L)</td>
</tr>
<tr>
<td>alpha-2</td>
<td>0.9 g/dL (9 g/L)</td>
</tr>
<tr>
<td>beta</td>
<td>0.8 g/dL (8 g/L)</td>
</tr>
<tr>
<td>gamma</td>
<td>1.4 g/dL (14 g/L)</td>
</tr>
<tr>
<td></td>
<td>6.0-8.0 g/dL (60-80 g/L)</td>
</tr>
<tr>
<td></td>
<td>3.6-5.2 g/dL (36-52 g/L)</td>
</tr>
<tr>
<td></td>
<td>0.1-0.4 g/d (1-4 g/L)</td>
</tr>
<tr>
<td></td>
<td>0.4-1.0 g/dL (4-10 g/L)</td>
</tr>
<tr>
<td></td>
<td>0.5-1.2 g/dL (5-12 g/L)</td>
</tr>
<tr>
<td></td>
<td>0.6-1.6 g/dL (6-16 g/L)</td>
</tr>
</tbody>
</table>

This electrophoresis pattern is consistent with:

a  cirrhosis  
b  monoclonal gammopathy  
c  polyclonal gammopathy (eg, chronic inflammation)  
d  alpha-1 antitrypsin deficiency; severe emphysema

Refer to the following illustration:

<table>
<thead>
<tr>
<th>Patient values</th>
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</tr>
</thead>
<tbody>
<tr>
<td>total protein</td>
<td>8.9 g/dL (89 g/L)</td>
</tr>
<tr>
<td>albumin</td>
<td>4.8 g/dL (48 g/L)</td>
</tr>
<tr>
<td>alpha-1</td>
<td>0.3 g/dL (3 g/L)</td>
</tr>
<tr>
<td>alpha-2</td>
<td>0.7 g/dL (7 g/L)</td>
</tr>
<tr>
<td>beta</td>
<td>0.8 g/dL (8 g/L)</td>
</tr>
<tr>
<td>gamma</td>
<td>2.3 g/dL (23 g/L)</td>
</tr>
<tr>
<td></td>
<td>6.0-8.0 g/dL (60-80 g/L)</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

The serum protein electrophoresis pattern is consistent with:

a  cirrhosis  
b  acute inflammation  
c  monoclonal gammopathy  
d  polyclonal gammopathy (eg, chronic inflammation)
Refer to the following pattern:

<table>
<thead>
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<tr>
<td>beta</td>
<td>0.5-1.2 g/dL (5-12 g/L)</td>
</tr>
<tr>
<td>gamma</td>
<td>0.6-1.6 g/dL (6-16 g/L)</td>
</tr>
</tbody>
</table>

This pattern is consistent with:

- cirrhosis
- acute inflammation
- polyclonal gammopathy (eg, chronic inflammation)
- alpha-1 antitrypsin deficiency; severe emphysema

A characteristic of the Bence Jones protein that is used to distinguish it from other urinary proteins is its solubility:

- a in ammonium sulfate
- b in sulfuric acid
- c at 40°- 60°C
- d at 100°C

The electrophoretic pattern of plasma sample as compared to a serum sample shows a:

- a broad prealbumin peak
- b sharp fibrinogen peak
- c diffuse pattern because of the presence of anticoagulants
- d decreased globulin fraction

At a pH of 8.6 the gamma globulins move toward the cathode, despite the fact that they are negatively charged. What is this phenomenon called?

- a reverse migration
- b molecular sieve
- c endosmosis
- d migratory inhibition factor
Refer to the following illustration:

### Patient values | Reference values
---|---
total protein | 7.8 g/dL (78 g/L) | 6.0-8.0 g/dL (60-80 g/L)
albumin | 3.0 g/dL (30 g/L) | 3.6-5.2 g/dL (36-52 g/L)
alpha\(_1\) | 0.4 g/dL (4 g/L) | 0.1-0.4 g/dL (1-4 g/L)
alpha\(_2\) | 1.8 g/dL (18 g/L) | 0.4-1.0 g/dL (4-10 g/L)
beta | 0.5 g/dL (5 g/L) | 0.5-1.2 g/dL (5-12 g/L)
gamma | 1.1 g/dL (11 g/L) | 0.6-1.6 g/dL (6-16 g/L)

The serum protein electrophoresis pattern is consistent with:

- **a** cirrhosis
- **b** acute inflammation
- **c** polyclonal gammopathy (eg, chronic inflammation)
- **d** alpha-1-antitrypsin deficiency; severe emphysema

Refer to the following illustration:

### Patient values | Reference values
---|---
total protein | 8.5 g/dL (85 g/L) | 6.0-8.0 g/dL (60-80 g/L)
albumin | 4.3 g/dL (43 g/L) | 3.6-5.2 g/dL (36-52 g/L)
alpha\(_1\) | 0.3 g/dL (3 g/L) | 0.1-0.4 g/dL (1-4 g/L)
alpha\(_2\) | 0.7 g/dL (7 g/L) | 0.4-1.0 g/dL (4-10 g/L)
beta | 0.9 g/dL (9 g/L) | 0.5-1.2 g/dL (5-12 g/L)
gamma | 2.3 g/dL (23 g/L) | 0.6-1.6 g/dL (6-16 g/L)

The above serum protein electrophoresis pattern is consistent with:

- **a** cirrhosis
- **b** monoclonal gammopathy
- **c** polyclonal gammopathy (eg, chronic inflammation)
- **d** alpha-1-antitrypsin deficiency; severe emphysema

Analysis of CSF for oligoclonal bands is used to screen for which of the following disease states?

- **a** multiple myeloma
- **b** multiple sclerosis
- **c** myasthenia gravis
- **d** von Willebrand disease
The identification of Bence Jones protein is best accomplished by:

- a sulfosalicylic acid test
- b urine reagent strips
- c immunofixation
- d electrophoresis

Total iron-binding capacity measures the serum iron transporting capacity of:

- a hemoglobin
- b ceruloplasmin
- c transferrin
- d ferritin

The first step in the quantitation of serum iron is:

- a direct reaction with appropriate chromogen
- b iron saturation of transferrin
- c free iron precipitation
- d separation of iron from transferring

A patient's blood was drawn at 8 AM for a serum iron determination. The result was 85 µg/dL (15.2 µmol/L). A repeat specimen was drawn at 8 PM; the serum was stored at 4°C and run the next morning. The result was 40 µg/dL (7.2 µmol/L). These results are most likely due to:

- a iron deficiency anemia
- b improper storage of the specimen
- c possible liver damage
- d the time of day the second specimen was drawn

An elevated serum iron with normal iron binding capacity is most likely associated with:

- a iron deficiency anemia
- b renal damage
- c pernicious anemia
- d septicemia

Decreased serum iron associated with increased TIBC is compatible with which of the following disease states?

- a anemia of chronic infection
- b iron deficiency anemia
- c chronic liver disease
- d nephrosis

A patient has the following results:

<table>
<thead>
<tr>
<th></th>
<th>Patient values</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td>serum iron</td>
<td>250 µg/dL (44.8 µmol/L)</td>
<td>60-150 µg/dL (10.7-26.9 µmol/L)</td>
</tr>
<tr>
<td>TIBC</td>
<td>350 µg/dL (62.7 µmol/L)</td>
<td>300-350 µg/dL (53.7-62.7 µmol/L)</td>
</tr>
</tbody>
</table>

The best conclusion is that this patient has:

- a normal iron status
- b iron deficiency anemia
- c chronic disease
- d iron hemochromatosis

To assure an accurate ammonia level result, the specimen should be:

- a incubated at 37°C prior to testing
- b spun and separated immediately, tested as routine
- c spun, separated, iced, and tested immediately
- d stored at room temperature until tested
106. Erroneous ammonia levels can be eliminated by all of the following except:
   a. assuring water and reagents are ammonia-free
   b. separating plasma from cells and performing test analysis as soon as possible
   c. drawing the specimen in a prechilled tube and immersing the tube in ice
   d. storing the specimen protected from light until the analysis is done

107. A critically ill patient becomes comatose. The physician believes the coma is due to hepatic failure. The assay most helpful in this diagnosis is:
   a. ammonia
   b. ALT
   c. AST
   d. GGT

108. A serum sample demonstrates an elevated result when tested with the Jaffe reaction. This indicates:
   a. prolonged hypothermia
   b. renal functional impairment
   c. pregnancy
   d. arrhythmia

109. In order to prepare 100 mL of 15 mg/dL BUN (5.35 mmol/L) working standard from a stock standard containing 500 mg/dL (178.5 mmol/L) of urea nitrogen, the number of mL of stock solution that should be used is:
   a. 3 mL
   b. 5 mL
   c. 33 mL
   d. 75 mL

110. A patient with glomerulonephritis is most likely to present with the following serum results:
   a. creatinine decreased
   b. calcium increased
   c. phosphorous decreased
   d. BUN increased

111. The principle excretory form of nitrogen is:
   a. amino acids
   b. creatinine
   c. urea
   d. uric acid

112. In the Jaffe reaction, creatinine reacts with:
   a. alkaline sulfosalazine solution to produce an orange-yellow complex
   b. potassium iodide to form a reddish-purple complex
   c. sodium nitroferricyanide to yield a reddish-brown color
   d. alkaline picate solution to yield an orange-red complex

113. Creatinine clearance is used to estimate the:
   a. tubular secretion of creatinine
   b. glomerular secretion of creatinine
   c. renal glomerular and tubular mass
   d. glomerular filtration rate
A blood creatinine value of 5.0 mg/dL (442.0 µmol/L) is most likely to be found with which of the following blood values?

- **a** osmolality: 292 mOsm/kg
- **b** uric acid: 8 mg/dL (475.8 µmol/L)
- **c** urea nitrogen: 80 mg/dL (28.56 mmol/L)
- **d** ammonia: 80 µg/dL (44 µmol/L)

Technical problems encountered during the collection of an amniotic fluid specimen caused doubt as to whether the specimen was amniotic in origin. Which of the following procedures would best establish that the fluid is amniotic in origin?

- **a** measurement of absorbance at 450 nm
- **b** creatinine measurement
- **c** lecithin/sphingomyelin ratio
- **d** human amniotic placental lactogen (HPL)

Which of the following represents the end product of purine metabolism in humans?

- **a** AMP and GMP
- **b** DNA and RNA
- **c** allantoin
- **d** uric acid

Which of the following substances is the biologically active precursor of a fat soluble vitamin?

- **a** biotin
- **b** retinol
- **c** folic acid
- **d** ascorbic acid

The troponin complex consists of:

- **a** troponin T, calcium and tropomyosin
- **b** troponin C, troponin I and troponin T
- **c** troponin I, actin, and tropomyosin
- **d** troponin C, myoglobin, and actin

The presence of C-reactive protein in the blood is an indication of:

- **a** a recent streptococcal infection
- **b** recovery from a pneumococcal infection
- **c** an inflammatory process
- **d** a state of hypersensitivity

Oligoclonal bands are present on electrophoresis of concentrated CSF and also on concurrently tested serum of the same patient. The proper interpretation is:

- **a** diagnostic for primary CNS tumor
- **b** diagnostic for multiple sclerosis
- **c** CNS involvement by acute leukemia
- **d** nondiagnostic for multiple sclerosis
121 Which of the following is an example of a peptide bond?

- A
- B
- C
- D

122 90% of the copper present in the blood is bound to:

- a transferrin
- b ceruloplasmin
- c albumin
- d cryoglobulin

123 Which of the following determinations is useful in prenatal diagnosis of open neural tube defects?

- a amniotic fluid alpha-fetoprotein
- b amniotic fluid estriol
- c maternal serum estradiol
- d maternal serum estrone

124 Below are the results of a protein electrophoresis:

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Rel%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>2</td>
<td>64.5</td>
</tr>
<tr>
<td>3</td>
<td>3.6</td>
</tr>
<tr>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>12.6</td>
</tr>
<tr>
<td>6</td>
<td>7.9</td>
</tr>
</tbody>
</table>

These results are consistent with a(n):

- a normal serum protein pattern
- b normal CSF protein pattern
- c abnormal serum protein pattern
- d abnormal CSF protein pattern

125 Serum concentrations of vitamin B₁₂ are elevated in:

- a pernicious anemia in relapse
- b patients on chronic hemodialysis
- c chronic granulocytic leukemia
- d Hodgkin disease
Absorption of vitamin B₁₂ requires the presence of:
- intrinsic factor
- gastrin
- secretin
- folic acid

The procedure used to determine the presence of neural tube defects is:
- lecithin/sphingomyelin ratio
- amniotic fluid creatinine
- measurement of absorbance at 450 nm
- alpha-fetoprotein

The principle of the occult blood test depends upon the:
- coagulase ability of blood
- oxidative power of atmospheric oxygen
- hydrogen peroxide in hemoglobin
- peroxidase-like activity of hemoglobin

A breakdown product of hemoglobin is:
- lipoprotein
- bilirubin
- hematoxylin
- Bence Jones protein

Hemoglobin S can be separated from hemoglobin D by:
- electrophoresis on a different medium and acidic pH
- hemoglobin A₂ quantitation
- electrophoresis at higher voltage
- Kleihauer-Betke acid elution

On electrophoresis at alkaline pH, which of the following is the slowest migrating hemoglobin?
- Hgb A
- Hgb S
- Hgb C
- Hgb F

The hemoglobin that is resistant to alkali (KOH) denaturation is:
- A
- A₂
- C
- F
The following bilirubin results are obtained on a patient:

- day 1: 4.3 mg/dL (73.5 μmol/L)
- day 2: 4.6 mg/dL (78.7 μmol/L)
- day 3: 4.5 mg/dL (77.0 μmol/L)
- day 4: 2.2 mg/dL (37.6 μmol/L)
- day 5: 4.4 mg/dL (75.2 μmol/L)
- day 6: 4.5 mg/dL (77.0 μmol/L)

Given that the controls were within range each day, what is a probable explanation for the result on day 4?

- a no explanation necessary
- b serum, not plasma, was used for testing
- c specimen had prolonged exposure to light
- d specimen was hemolyzed

Urobilinogen is formed in the:

- a kidney
- b spleen
- c liver
- d intestine

In bilirubin determinations, the purpose of adding a concentrated caffeine solution or methyl alcohol is to:

- a allow indirect bilirubin to react with color reagent
- b dissolve conjugated bilirubin
- c precipitate protein
- d prevent any change in pH

If the total bilirubin is 3.1 mg/dL (53.0 μmol/L) and the conjugated bilirubin is 2.0 mg/dL (34.2 μmol/L), the unconjugated bilirubin is:

- a 0.5 mg/dL (8.6 μmol/L)
- b 1.1 mg/dL (18.8 μmol/L)
- c 2.2 mg/dL (37.6 μmol/L)
- d 5.1 mg/dL (87.2 μmol/L)

The principle of the tablet test for bilirubin in urine or feces is:

- a the reaction between bile and 2,4-dichloronitrobenzene to a yellow color
- b the liberation of oxygen by bile to oxidize orthotolidine to a blue-purple color
- c chemical coupling of bile with a diazonium salt to form a brown color
- d chemical coupling of bilirubin with a diazonium salt to form a purple color

A serum sample was assayed for bilirubin at 10 AM, and the result was 12 mg/dL (205.6 μmol/L). The same sample was retested at 3 PM. The result now is 8 mg/dL (136.8 μmol/L). The most likely explanation for this discrepancy is:

- a the reagent has deteriorated
- b the sample was exposed to light
- c a calculation error in the first assay
- d the sample was not refrigerated

Serial bilirubin determinations are charted below.

<table>
<thead>
<tr>
<th>Day</th>
<th>Collected</th>
<th>Assayed</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 AM</td>
<td>8 AM</td>
<td>14.0 mg/dL (239.4 μmol/L)</td>
</tr>
<tr>
<td>2</td>
<td>7 AM</td>
<td>6 PM</td>
<td>9.0 mg/dL (153.9 μmol/L)</td>
</tr>
<tr>
<td>3</td>
<td>6 AM</td>
<td>8 AM</td>
<td>15.0 mg/dL (256.5 μmol/L)</td>
</tr>
</tbody>
</table>

The best explanation for the results is:

- a sample hemolysis and hemoglobin deterioration
- b sample exposure to light
- c sample left in warm location
- d reagent deterioration
In the liver, bilirubin is converted to:

- urobilinogen
- urobilin
- bilirubin-albumin complex
- bilirubin diglucuronide

In which of the following disease states is conjugated bilirubin a major serum component?

- biliary obstruction
- hemolysis
- neonatal jaundice
- erythroblastosis fetalis

Kernicterus is an abnormal accumulation of bilirubin in:

- heart tissue
- brain tissue
- liver tissue
- kidney tissue

In which of the following conditions does decreased activity of glucuronyl transferase result in increased unconjugated bilirubin and kernicterus in neonates?

- Gilbert disease
- Rotor syndrome
- Dubin-Johnson syndrome
- Crigler-Najjar syndrome

A 21-year-old man with nausea, vomiting, and jaundice has the following laboratory findings:

<table>
<thead>
<tr>
<th>Test</th>
<th>Patient</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>total serum bilirubin</td>
<td>8.5 mg/dL (145.4 μmol/L)</td>
<td>0-1.0 mg/dL (0.0-17.1 μmol/L)</td>
</tr>
<tr>
<td>conjugated serum bilirubin</td>
<td>6.1 mg/dL (104.3 μmol/L)</td>
<td>0-0.5 mg/dL (0.0-8.6 μmol/L)</td>
</tr>
<tr>
<td>urine urobilinogen</td>
<td>increased</td>
<td></td>
</tr>
<tr>
<td>fecal urobilinogen</td>
<td>decreased</td>
<td></td>
</tr>
<tr>
<td>urine bilirubin</td>
<td>positive</td>
<td></td>
</tr>
<tr>
<td>AST</td>
<td>300 U/L</td>
<td>0-50 U/L</td>
</tr>
<tr>
<td>alkaline phosphatase</td>
<td>170 U/L</td>
<td>0-150 U/L</td>
</tr>
</tbody>
</table>

These can best be explained as representing:

- unconjugated hyperbilirubinemia, probably due to hemolysis
- unconjugated hyperbilirubinemia, probably due to toxic liver damage
- conjugated hyperbilirubinemia, probably due to biliary tract disease
- conjugated hyperbilirubinemia, probably due to hepatocellular obstruction
**Biochemical profile:**

<table>
<thead>
<tr>
<th>Test</th>
<th>Patient values</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>total protein</td>
<td>7.3 g/dL (73 g/L)</td>
<td>6.0 - 8.0 g/dL (80-80 g/L)</td>
</tr>
<tr>
<td>albumin</td>
<td>4.1 g/dL (41 g/L)</td>
<td>3.5 - 5.0 g/dL (35-50 g/L)</td>
</tr>
<tr>
<td>calcium</td>
<td>9.6 mg/dL (2.4 mmol/L)</td>
<td>8.5 - 10.5 mg/dL (2.1-2.6 mmol/L)</td>
</tr>
<tr>
<td>phosphorus</td>
<td>3.3 mg/dL (1.06 mmol/L)</td>
<td>2.5 - 4.5 mg/dL (0.80-1.45 mmol/L)</td>
</tr>
<tr>
<td>glucose</td>
<td>95 mg/dL (5.2 mmol/L)</td>
<td>65 - 110 mg/dL (3.6-6.1 mmol/L)</td>
</tr>
<tr>
<td>BUN</td>
<td>16 mg/dL (5.71 mmol/L)</td>
<td>10 - 20 mg/dL (3.57-7.14 mmol/L)</td>
</tr>
<tr>
<td>uric acid</td>
<td>6.0 mg/dL (356.9 μmol/L)</td>
<td>2.5 - 8.0 mg/dL (148.7-475.8 μmol/L)</td>
</tr>
<tr>
<td>creatinine</td>
<td>1.2 mg/dL (106.1 μmol/L)</td>
<td>0.7 - 1.4 mg/dL (61.9-123.8 μmol/L)</td>
</tr>
<tr>
<td>total bilirubin</td>
<td>3.7 mg/dL (63.3 μmol/L)</td>
<td>0.2 - 0.9 mg/dL (3.4-15.4 μmol/L)</td>
</tr>
<tr>
<td>alkaline phosphatase</td>
<td>275 U/L</td>
<td>30 - 80 U/L</td>
</tr>
<tr>
<td>lactate dehydrogenase</td>
<td>185 U/L</td>
<td>100 - 225 U/L</td>
</tr>
<tr>
<td>AST</td>
<td>75 U/L</td>
<td>10 - 40 U/L</td>
</tr>
</tbody>
</table>

The results of the biochemical profile are most consistent with:

- a. viral hepatitis
- b. hemolytic anemia
- c. common bile duct stone
- d. chronic active hepatitis

146 A stool specimen that appears black and tarry should be tested for the presence of:

- a. occult blood
- b. fecal fat
- c. trypsin
- d. excess mucus

147 What substance gives feces its normal color?

- a. uroerythrin
- b. urochrome
- c. urobilin
- d. urobinogen

148 A condition in which erythrocyte protoporphyria is increased is:

- a. acute intermittent porphyria
- b. iron deficiency anemia
- c. porphyria cutanea tarda
- d. acute porphyrinic attack

149 Which of the following elevates carboxyhemoglobin?

- a. nitrite poisoning
- b. exposure to carbon monoxide
- c. sulfa drug toxicity
- d. sickle cell anemia

150 The reason carbon monoxide is so toxic is because it:

- a. is a protoplastic poison
- b. combines with cytochrome oxidase
- c. has 200 times the affinity of oxygen for hemoglobin binding sites
- d. sensitizes the myocardium
Detection of carriers of hereditary coproporphyria should include analysis of:
- 24-hour urine for porphobilinogen
- fresh morning urine for delta-aminolevulinic acid
- erythrocyte protoporphyrin
- 24-hour urine for porphyrin

A fresh urine sample is received for analysis for “porphyrins” or “porphyria” without further information or specifications. Initial analysis should include:
- porphyrin screen and quantitative total porphyrin
- quantitative total porphyrin and porphobilinogen screen
- porphyrin and porphobilinogen screen
- porphobilinogen screen and ion-exchange analysis for porphobilinogen

Which of the following enzymes of heme biosynthesis is inhibited by lead?
- aminolevulinate synthase
- porphobilinogen synthase
- uroporphyrinogen synthase
- bilirubin synthetase

Serum haptoglobin:
- is decreased in patients with tissue injury and neoplasia
- is increased in patients with prosthetic heart valves
- can be separated into distinct phenotypes by starch-gel electrophoresis
- binds heme

The most specific enzyme test for acute pancreatitis is:
- acid phosphatase
- trypsin
- amylase
- lipase

Which of the following enzymes are used in the diagnosis of acute pancreatitis?
- amylase (AMS) and lipase (LPS)
- aspartate aminotransferase (AST) and alanine aminotransferase (ALT)
- 5’-nucleotidase (5’N) and gamma-glutamyl transferase (GGT)
- aspartate aminotransferase (AST) and lactate dehydrogenase (LD)

Which of the following enzymes catalyzes the conversion of starch to glucose and maltose?
- malate dehydrogenase (MD)
- amylase (AMS)
- creatine kinase (CK)
- isocitric dehydrogenase (ICD)

Which of the following sets of results would be consistent with macroamylasemia?
- normal serum amylase and elevated urine amylase values
- increased serum amylase and normal urine amylase values
- increased serum and urine amylase values
- normal serum and urine amylase values
A physician suspects his patient has pancreatitis. Which test(s) would be most indicative of this disease?
   a. creatinine  
   b. LD isoenzymes  
   c. beta-hydroxybutyrate  
   d. amylase

Aspartate amino transferase (AST) is characteristically elevated in diseases of the:
   a. liver  
   b. kidney  
   c. intestine  
   d. pancreas

Amino transferase enzymes catalyze the:
   a. exchange of amino groups and sulphydryl groups between alpha-amino and sulfur-containing acids  
   b. exchange of amino and keto groups between alpha-amino and alpha-keto acids  
   c. hydrolysis of amino acids and keto acids  
   d. reversible transfer of hydrogen from amino acids to coenzyme

Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) are both elevated in which of the following diseases?
   a. muscular dystrophy  
   b. viral hepatitis  
   c. pulmonary emboli  
   d. infectious mononucleosis

The greatest activities of serum AST and ALT are seen in which of the following?
   a. acute viral hepatitis  
   b. primary biliary cirrhosis  
   c. metastatic hepatic cirrhosis  
   d. alcoholic cirrhosis

Malic dehydrogenase is added to the aspartate aminotransaminase (AST) reaction to catalyze the conversion of:
   a. alpha-ketoglutarate to aspartate  
   b. alpha-ketoglutarate to malate  
   c. aspartate to oxalacetate  
   d. oxalacetate to malate

Given the following results:
   alkaline phosphatase: slight increase  
   aspartate amino transferase: marked increase  
   alanine amino transferase: marked increase  
   gamma-glutamyl transferase: slight increase

This is most consistent with:
   a. acute hepatitis  
   b. chronic hepatitis  
   c. obstructive jaundice  
   d. liver hemangioma

Which of the following clinical disorders is associated with the greatest elevation of lactate dehydrogenase isoenzyme 1?
   a. pneumonia  
   b. glomerulonephritis  
   c. pancreatitis  
   d. pernicious anemia
167 The enzyme, which exists chiefly in skeletal muscle, heart, and brain, is grossly elevated in active muscular dystrophy, and rises early in myocardial infarction is:

a. lipase
b. transaminase
c. lactate dehydrogenase
d. creatine kinase

168 The enzyme present in almost all tissues that may be separated by electrophoresis into 5 components is:

a. lipase
b. transaminase
c. creatine kinase
d. lactate dehydrogenase

169 A common cause of a falsely increased LD<sub>1</sub> fraction of lactic dehydrogenase is:

a. specimen hemolysis
b. liver disease
c. congestive heart failure
d. drug toxicity

170 The presence of which of the following isoenzymes indicates acute myocardial damage?

a. CKMM
b. CKMB
c. CKBB
d. none

171 In which of the following conditions would a normal level of creatine kinase be found?

a. acute myocardial infarct
b. hepatitis
c. progressive muscular dystrophy
d. intramuscular injection

172 Of the following diseases, the one most often associated with elevations of lactate dehydrogenase isoenzymes 4 and 5 on electrophoresis is:

a. liver disease
b. hemolytic anemia
c. myocardial infarction
d. pulmonary edema

173 When myocardial infarction occurs, the first enzyme to become elevated is:

a. CK
b. LD
c. AST
d. ALT

174 A scanning of a CK isoenzyme fractionation revealed 2 peaks: a slow cathodic peak (CKMM) and an intermediate peak (CKMB). A possible interpretation for this pattern is:

a. brain tumor
b. muscular dystrophy
c. myocardial infarction
d. viral hepatitis
An electrophoretic separation of lactate dehydrogenase isoenzymes that demonstrates an elevation in LD-1 and LD-2 in a “flipped” pattern is consistent with:

- a) myocardial infarction
- b) viral hepatitis
- c) pancreatitis
- d) renal failure

Increased total serum lactic dehydrogenase (LD) activity, confined to fractions 4 and 5 is most likely to be associated with:

- a) pulmonary infarction
- b) hemolytic anemia
- c) myocardial infarction
- d) acute viral hepatitis

A 10-year-old child was admitted to pediatrics with an initial diagnosis of skeletal muscle disease. The best confirmatory tests would be:

- a) creatine kinase and isocitrate dehydrogenase
- b) gamma-glutamyl transferase and alkaline phosphatase
- c) aldolase and creatine kinase
- d) lactate dehydrogenase and malate dehydrogenase

In the immunoinhibition phase of the CKMB procedure:

- a) M subunit is inactivated
- b) B subunit is inactivated
- c) MB is inactivated
- d) BB is inactivated

The presence of increased CKMB activity on a CK electrophoresis pattern is most likely found in a patient suffering from:

- a) acute muscular stress following strenuous exercise
- b) malignant liver disease
- c) myocardial infarction
- d) severe head injury

Refer to the following illustration:

![LD isoenzyme scan diagram]

Which of the following is the most likely interpretation of the LD isoenzyme scan illustrated above?

- a) myocardial infarction
- b) megaloblastic anemia
- c) acute pancreatitis
- d) viral hepatitis
181 Increased serum lactic dehydrogenase activity due to elevation of fast fraction (1 and 2) on electrophoretic separation is caused by:

- a nephrotic syndrome
- b hemolytic anemia
- c pancreatitis
- d hepatic damage

182 A serum sample drawn in the emergency room from a 42-year-old man yielded the following laboratory results:

<table>
<thead>
<tr>
<th>Patient</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK:</td>
<td>185 U/L</td>
</tr>
<tr>
<td></td>
<td>15-160 U/L</td>
</tr>
<tr>
<td>AST:</td>
<td>123 U/L</td>
</tr>
<tr>
<td></td>
<td>0-48 U/L</td>
</tr>
<tr>
<td>CKMB:</td>
<td>6 U/L</td>
</tr>
<tr>
<td></td>
<td>2-12 U/L</td>
</tr>
</tbody>
</table>

Which of the following conditions might account for these values?

- a crush injury to the thigh
- b cerebrovascular accident
- c pulmonary infarction
- d early acute hepatitis

183 Given the following results:

- alkaline phosphatase: marked increase
- aspartate amino transferase: slight increase
- alanine amino transferase: slight increase
- gamma-glutamyl transferase: marked increase

This is most consistent with:

- a acute hepatitis
- b osteitis fibrosa
- c chronic hepatitis
- d obstructive jaundice

184 Given the following results:

- alkaline phosphatase: slight increase
- aspartate amino transferase: slight increase
- alanine amino transferase: slight increase
- gamma-glutamyl transferase: slight increase

This is most consistent with:

- a acute hepatitis
- b chronic hepatitis
- c obstructive jaundice
- d liver hemangioma

185 What specimen preparation is commonly used to perform the alkaline phosphatase isoenzyme determination?

- a serum is divided into 2 aliquots, one is frozen and the other is refrigerated
- b serum is divided into 2 aliquots, one is heated at 56°C and the other is unheated
- c no preparation is necessary since the assay uses EDTA plasma
- d protein-free filtrate is prepared first

186 Regan isoenzyme has the same properties as alkaline phosphatase that originates in the:

- a skeleton
- b kidney
- c intestine
- d placenta
The most heat labile fraction of alkaline phosphatase is obtained from:

- a. liver
- b. bone
- c. intestine
- d. placenta

The most sensitive enzymatic indicator for liver damage from ethanol intake is:

- a. alanine aminotransferase (ALT)
- b. aspartate aminotransferase (AST)
- c. gamma-glutamyl transferase (GGT)
- d. alkaline phosphatase

Isoenzyme assays are performed to improve:

- a. precision
- b. accuracy
- c. sensitivity
- d. specificity

The protein portion of an enzyme complex is called the:

- a. apoenzyme
- b. coenzyme
- c. holoenzyme
- d. proenzyme

Which of the following chemical determinations may be of help in establishing the presence of seminal fluid?

- a. lactic dehydrogenase (LD)
- b. isocitrate dehydrogenase (ICD)
- c. acid phosphatase
- d. alkaline phosphatase

Which of the following enzyme substrates for prostatic acid phosphatase is best for the continuous monitoring method?

- a. phenyl-phosphate
- b. thymolphthalein monophosphate
- c. alpha-naphthyl-phosphate
- d. beta-glycerophosphate

Lactate dehydrogenase, malate dehydrogenase, isocitrate dehydrogenase, and hydroxybutyrate dehydrogenase all:

- a. are liver enzymes
- b. are cardiac enzymes
- c. catalyze oxidation-reduction reactions
- d. are class III enzymes

Lipids and Lipoproteins

High levels of which lipoprotein class are associated with decreased risk of accelerated atherosclerosis?

- a. chylomicrons
- b. VLDL
- c. LDL
- d. HDL
The most consistent analytical error involved in the routine determination of HDL-cholesterol is caused by:

- a incomplete precipitation of LDL-cholesterol
- b coprecipitation of HDL- and LDL-cholesterol
- c inaccurate protein estimation of HDL-cholesterol
- d a small concentration of apoB-containing lipoproteins after precipitation

If the LDL-cholesterol is to be calculated by the Friedewald formula, what are the 2 measurements that need to be carried out by the same chemical procedure?

- a total cholesterol and HDL-cholesterol
- b total cholesterol and triglyceride
- c triglyceride and chylomicrons
- d apolipoprotein A and apolipoprotein B

The chemical composition of HDL-cholesterol corresponds to:

<table>
<thead>
<tr>
<th>Triglyceride</th>
<th>Cholesterol</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>60%</td>
<td>15%</td>
</tr>
<tr>
<td>b</td>
<td>10%</td>
<td>45%</td>
</tr>
<tr>
<td>c</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>d</td>
<td>85%</td>
<td>5%</td>
</tr>
</tbody>
</table>

In familial hypercholesterolemia, the hallmark finding is an elevation of:

- a low-density lipoproteins
- b chylomicrons
- c high-density lipoproteins
- d apolipoprotein A

Premature atherosclerosis can occur when which of the following becomes elevated?

- a chylomicrons
- b prostaglandins
- c low-density lipoproteins
- d high-density lipoproteins

Transportation of 60%-75% of the plasma cholesterol is performed by:

- a chylomicrons
- b very low-density lipoproteins
- c low-density lipoproteins
- d high-density lipoproteins

Which of the following diseases results from a familial absence of high density lipoprotein?

- a Krabbe disease
- b Gaucher disease
- c Tangier disease
- d Tay-Sachs disease

A 1-year-old girl with a hyperlipoproteinemia and lipase deficiency has the following lipid profile:

- cholesterol: 300 mg/dl (7.77 mmol/L)
- LDL: increased
- HDL: decreased
- triglycerides: 200 mg/dl (2.26 mmol/L)
- chylomicrons: present

A serum specimen from this patient that was refrigerated overnight would most likely be:

- a clear
- b cloudy
- c creamy layer over cloudy serum
- d creamy layer over clear serum
236 Which of the following lipid results would be expected to be falsely elevated on a serum specimen from a nonfasting patient?

- cholesterol
- triglyceride
- HDL
- LDL

204 A 9-month-old boy from Israel has gradually lost the ability to sit up, and develops seizures. He has an increased amount of a phospholipid called GM2-ganglioside in his neurons, and he lacks the enzyme hexosaminidase A in his leukocytes. These findings suggest:

- Neimann-Pick disease
- Tay-Sachs disease
- phenylketonuria
- Hurler syndrome

205 In amniotic fluid, the procedure used to determine fetal lung maturity is:

- lecithin/sphingomyelin ratio
- creatinine
- measurement of absorbance at 450 nm
- alpha-fetoprotein

206 Refer to the following illustration:

![Amniotic Fluid Phospholipid Analysis](image)

The class of phospholipid surfactants represented by the dotted line on the amniotic fluid analysis shown above is thought to originate in what fetal organ system?

- cardiovascular
- pulmonary
- hepatic
- placental

207 A fasting serum sample from an asymptomatic 43-year-old woman is examined visually and chemically with the following results:

- Initial appearance of serum: milky
- Appearance of serum after overnight refrigeration: cream layer over turbid serum
- Triglyceride level: 2,000 mg/dL (22.6 mmol/L)
- Cholesterol level: 550 mg/dL (14.25 mmol/L)

This sample contains predominantly:

- chylomicrons, alone
- chylomicrons and very low-density lipoproteins (VLDL)
- very low-density lipoproteins (VLDL) and low-density lipoproteins (LDL)
- high-density lipoproteins (HDL)
208 Chylomicrons are present in which of the following dyslipidemias?
   a familial hypercholesterolemia
   b hypertriglyceridemia
   c deficiency in lipoprotein lipase activity
   d familial hyperalphalipoproteinemia

209 The function of the major lipid components of the very low-density lipoproteins (VLDL) is to transport:
   a cholesterol from peripheral cells to the liver
   b cholesterol and phospholipids to peripheral cells
   c exogenous triglycerides
   d endogenous triglycerides

210 Turbidity in serum suggests elevation of:
   a cholesterol
   b total protein
   c chylomicrons
   d albumin

*Endocrinology and Tumor Markers*

211 TSH is produced by the:
   a hypothalamus
   b pituitary gland
   c adrenal cortex
   d thyroid

212 A patient has the following thyroid profile:
   total T₄: decreased
   free T₄: decreased
   thyroid peroxidase antibody: positive
   TSH: decreased

This patient most probably has:
   a hyperthyroidism
   b hypothyroidism
   c a normal thyroid
   d Graves disease

213 A 45-year-old woman complains of fatigue, heat intolerance and hair loss. Total and free T₄ are abnormally low. If the TSH showed marked elevation, this would be consistent with:
   a Graves disease
   b an adenoma of the thyroid
   c thyrotoxicosis
   d primary hypothyroidism

214 The majority of thyroxine (T₄) is converted into the more biologically active hormone:
   a thyroglobulin
   b thyroid-stimulating hormone (TSH)
   c triiodothyronine (T₃)
   d thyrotropin-releasing hormone
A 2-year-old child with a decreased serum T₄ 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 thryroxine binding globulin (TBG)
- b thyroid-stimulating hormone (TSH)
- c triiodothyronine (T₃)
- d cholesterol

Assays for free T₄ measure hormone not bound to thyroxine-binding prealbumin, thyroxine-binding globulin and:

- a thyrotropin-releasing hormone
- b albumin
- c free T₃
- d thyroid-stimulating hormone

The recommended initial thyroid function test for either a healthy, asymptomatic patient or a patient with symptoms which may be related to a thyroid disorder is:

- a free thyroxine (free T₄)
- b thyroid-stimulating hormone (TSH)
- c total thyroxine (T₄)
- d triiodothyronine (T₃)

The screening test for congenital hypothyroidism is based upon:

- a TSH level in the newborn
- b thyroid-binding globulin level in the newborn
- c iodine level in the newborn
- d total thyroxine (T₄) level in the newborn

Which one of the following sets of results is consistent with primary hypothyroidism, (eg, Hashimoto thyroiditis):

<table>
<thead>
<tr>
<th>Result</th>
<th>TSH</th>
<th>T₄ (free thyroxine)</th>
<th>Antithyroidal antibody</th>
</tr>
</thead>
<tbody>
<tr>
<td>result A</td>
<td>decreased</td>
<td>decreased</td>
<td>positive</td>
</tr>
<tr>
<td>result B</td>
<td>increased</td>
<td>increased</td>
<td>positive</td>
</tr>
<tr>
<td>result C</td>
<td>normal</td>
<td>decreased</td>
<td>negative</td>
</tr>
<tr>
<td>result D</td>
<td>increased</td>
<td>decreased</td>
<td>positive</td>
</tr>
</tbody>
</table>

A 68-year-old female patient tells her physician of being “cold all the time” and recent weight gain, with no change in diet. The doctor orders a TSH level, and the laboratory reports a value of 8.7 μU/ ml (8.7 IU/L) (reference range = 0.5-5.0 μU/mL [0.5-5.0 IU/L]). This patient most likely has:

- a primary hypothyroidism
- b Graves disease
- c a TSH-secreting tumor
- d primary hyperthyroidism

Which of the following is secreted by the placenta and used for the early detection of pregnancy?

- a follicle-stimulating hormone (FSH)
- b human chorionic gonadotropin (HCG)
- c luteinizing hormone (LH)
- d progesterone
222 During pregnancy, the form of estrogen measured in urine is mostly:
   a. estradiol
   b. estriol
   c. estrone
   d. pregnanediol

223 Refer to the following graph:

![Graph showing HCG levels over 8 months.]

The HCG levels shown in the above graph most probably represent:
   a. hydatidiform mole following miscarriage at 4 months
   b. normal pregnancy
   c. development of hydatidiform mole
   d. miscarriage at 2 months with retained placenta

224 In amniotic fluid, the procedure used to detect hemolytic disease of the newborn is:
   a. measurement of absorbance at 450 nm
   b. creatinine
   c. lecithin/sphingomyelin ratio
   d. estriol

225 During a normal pregnancy, quantitative human chorionic gonadotropin (HCG) levels peak how many weeks after the last menstrual period?
   a. 2-4
   b. 8-10
   c. 14-16
   d. 18-20

226 "Laboratory A" measures maternal serum alpha-fetoprotein (MSAFP) at 16-18 weeks gestation as a screen for fetal disorders. The 16-week MSAFP median for Lab A is 32 μg/L. A 37-year-old woman has an MSAFP level of 34 μg/L at her 16th week. This result is consistent with:
   a. a normal MSAFP level for 16-week gestation
   b. possible neural tube defect, including spina bifida
   c. possible multiple birth (i.e., twins)
   d. possible trisomy disorder, including Down syndrome

227 Which of the following steroids is an adrenal cortical hormone?
   a. angiotensinogen
   b. aldosterone
   c. epinephrine
   d. growth hormone

228 What common substrate is used in the biosynthesis of adrenal steroids, including androgens and estrogens?
   a. cortisol
   b. catecholamines
   c. progesterone
   d. cholesterol
229 The biologically most active, naturally occurring androgen is:
   a androstenedione  
   b cortisol  
   c epiaandrosterone  
   d testosterone

230 Plasma for cortisol determinations were collected at 7 AM, after waking the patient, and at 10 PM that evening. The cortisol level of the morning sample was higher than the evening sample. This is consistent with:
   a a normal finding  
   b Cushing syndrome  
   c Addison disease  
   d hypopituitarism

231 Night blindness is associated with deficiency of which of the following vitamins?
   a A  
   b C  
   c niacin  
   d thiamine

232 Beriberi is associated with deficiency of vitamin:
   a A  
   b C  
   c niacin  
   d thiamine

233 Scurvy is associated with deficiency of which of the following vitamins?
   a A  
   b C  
   c niacin  
   d thiamine

234 Rickets is associated with deficiency of which of the following vitamins?
   a B₁  
   b C  
   c niacin  
   d D

235 Pellagra is associated with deficiency of which of the following vitamins?
   a A  
   b B₁  
   c thiamine  
   d niacin

236 The major action of angiotensin II is:
   a increased pituitary secretion of vasopressin  
   b increased vasoconstriction  
   c increased parathormone secretion by the parathyroid  
   d decreased adrenal secretion of aldosterone

237 The urinary excretion product measured as an indicator of epinephrine production is:
   a dopamine  
   b dihydroxyphenylalanine (DOPA)  
   c homovanillic acid  
   d vanillylmandelic acid (VMA)
238 Which of the following hormones regulates normal blood calcium levels?
   a. thyroxine
   b. estriol
   c. parathyroid hormone
   d. growth hormone

239 The most common form (95%) of congenital adrenal hyperplasia is 21-hydroxylase deficiency, which is detected by elevated plasma:
   a. cortisol
   b. aldosterone
   c. 17-OH-progesterone
   d. 11-deoxycortisol

240 A diagnosis of primary adrenal insufficiency requires demonstration of:
   a. decreased urinary 17-keto- and 17-hydroxysteroids
   b. decreased cortisol production
   c. impaired response to ACTH stimulation
   d. increased urinary cortisol excretion after metyrapone

241 The screen for adrenal cortical hyperfunction with the greatest sensitivity and specificity is:
   a. 24-hour urine free cortisol
   b. plasma cortisol
   c. urinary 17-hydroxycorticosteroids
   d. plasma corticosterone

242 A patient has signs and symptoms suggestive of acromegaly. The diagnosis would be confirmed if the patient had which of the following?
   a. an elevated serum phosphate concentration
   b. a decreased serum growth hormone releasing factor concentration
   c. no decrease in serum growth hormone concentration 90 minutes after oral glucose administration
   d. an increased serum somatostatin concentration

243 Estrogen and progesterone receptor assays are useful in identifying patients who are likely to benefit from endocrine therapy to treat which of the following?
   a. ovarian cancer
   b. breast cancer
   c. endometriosis
   d. amenorrhea

244 Which of the following sample collections would give an accurate assessment of potential excess cortisol production (hypercortisolism)?
   a. collect a plasma sample as a baseline, and another one-hour after administration of metyrapone
   b. collect a plasma sample at 8 AM only
   c. collect a 24-hour urine free cortisol
   d. collect a plasma sample at 8 AM and at 8 AM the next day

245 How is primary hypocortisolism (Addison disease) differentiated from secondary hypocortisolism (of pituitary origin)?
   a. adrenal corticotropic hormone (ACTH) is decreased in primary and elevated in secondary
   b. adrenal corticotropic hormone (ACTH) is elevated in primary and decreased in secondary
   c. low aldosterone and hypoglycemia present with secondary hypocortisolism
   d. normal cortisol levels and blood pressure with primary hypocortisolism
2: Chemistry | Endocrinology and Tumor Markers

246 Aldosterone is released by the adrenal cortex upon stimulation by:
   a. renin
   b. angiotensinogen
   c. angiotensin I
   d. angiotensin II

247 In developing the reference for a new EIA for CEA, the range for the normal population was broader than that published by the vendor. Controls are acceptable with a narrow coefficient of variation. This may be explained by:
   a. positive interference by another tumor marker
   b. population skewed to a younger age
   c. improper temperature control during assay
   d. inclusion of nonsmokers and smokers in the study population

248 Clinical assays for tumor markers are most important for:
   a. screening for the presence of cancer
   b. monitoring the course of a known cancer
   c. confirming the absence of disease
   d. identifying patients at risk for cancer

249 Detection of which of the following substances is most useful to monitor the course of a patient with testicular cancer?
   a. alpha-fetoprotein
   b. carcinoembryonic antigen
   c. prolactin
   d. testosterone

250 Increased concentrations of alpha-fetoprotein (AFP) in adults are most characteristically associated with:
   a. hepatocellular carcinoma
   b. alcoholic cirrhosis
   c. chronic active hepatitis
   d. multiple myeloma

251 Carcinoembryonic antigen (CEA) is most likely to be produced in a malignancy involving the:
   a. brain
   b. testes
   c. bone
   d. colon

252 Which of the following is useful in the detection and management of carcinoma of the prostate?
   a. total prostate-specific antigen
   b. prostatic acid phosphatase
   c. human chorionic gonadotropin
   d. alpha-fetoprotein

253 Which of the following statements most correctly describes the utility of clinical laboratory assays for tumor markers?
   a. tumor markers are useful to screen asymptomatic patients for tumors
   b. tumor markers are highly specific
   c. tumor markers indicate the likelihood of an individual developing a tumor
   d. tumor markers are useful in tracking the efficacy of treatment
254 Cancer antigen 125 (CA 125) is a tumor marker associated with:
   a breast carcinoma
   b colon cancer
   c lung cancer
   d ovarian and endometrial carcinoma

255 In addition to carcinoma of the prostate, elevated prostate-specific antigen (PSA) can occur due to:
   a aspirin therapy
   b exogenous steroid use
   c benign prostatic hyperplasia
   d statin therapy (cholesterol lowering drug)

TDM and Toxicology

256 Blood specimens for digoxin assays should be obtained between 8 hours or more after drug administration because:
   a tissue and serum levels need to reach equilibrium
   b serum digoxin concentration will be falsely low prior to 6 hours
   c all of the digoxin is in the cellular fraction prior to 6 hours
   d digoxin protein-binding interactions are minimal prior to 6 hours

257 A drug has a half-life of 6 hours. If a dose is given every 6 hours, a steady-state drug level would usually be achieved in:
   a 3-5 hours
   b 10-12 hours
   c 24-42 hours
   d 48-50 hours

258 Free therapeutic drug levels are usually higher when serum protein concentrations are below normal. In which of the following conditions would this most likely occur?
   a acute inflammation
   b nephrotic syndrome
   c pregnancy
   d multiple myeloma

259 Which of the following factors is not relevant to therapeutic drug monitoring (TDM) of the aminoglycosides, antibiotics and vancomycin?
   a intestinal absorption
   b nephrotoxicity
   c ototoxicity
   d renal function

260 The drug procainamide is prescribed to treat cardiac arrhythmia. What biologically active liver metabolite of procainamide is often measured simultaneously?
   a phenobarbital
   b quinidine
   c N-acetyl procainamide (NAPA)
   d lidocaine

261 Cocaine is metabolized to:
   a carbacholpine
   b codeine
   c hydrocodone
   d benzoylcegonine
262 The metabolite 11-nor-tetrahydrocannabinol-9-COOH can be detected by immunoassay 3-5 days after a single use of:
   a  methamphetamine  
b  cocaine  
c  benzodiazepine  
d  marijuana

263 A 3-year-old child was evaluated for abdominal pain and anorexia by a physician. A CBC revealed a hemoglobin of 9.8 g/dL (98 g/L) and basophilic stippling of the RBCs. The doctor should order further tests to check for poisoning from:
   a  arsenic  
b  iron  
c  mercury  
d  lead

264 Zinc protoporphyrin or free erythrocyte protoporphyrin measurements are useful to assess blood concentrations of:
   a  lead  
b  mercury  
c  arsenic  
d  beryllium

265 A carbonate salt used to control manic-depressive disorders is:
   a  digoxin  
b  acetaminophen  
c  lithium  
d  phenytoin

266 An antiepileptic (or anticonvulsant) used to control seizure disorders is:
   a  digoxin  
b  acetaminophen  
c  lithium  
d  phenytoin

267 A drug that relaxes the smooth muscles of the bronchial passages is:
   a  acetaminophen  
b  lithium  
c  phenytoin  
d  theophylline

268 A cardiac glycoside that is used in the treatment of congenital heart failure and arrhythmias by increasing the force and velocity of myocardial contraction is:
   a  digoxin  
b  acetaminophen  
c  lithium  
d  phenytoin

269 A salicylate level is performed to detect toxicity caused by ingestion of excess:
   a  acetaminophen  
b  aspirin  
c  ibuprofen  
d  pseudoephedrine
270 Lithium therapy is widely used in the treatment of:

- a. hypertension
- b. hyperactivity
- c. aggression
- d. manic-depressive (bipolar) disorder

271 Serum and urine copper levels are assayed on a hospital patient with the following results:

<table>
<thead>
<tr>
<th></th>
<th>Patient values</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td>serum Cu</td>
<td>20 μg/dL (3.1 μmol/L)</td>
<td>70-140 μg/dL (11.0-22.0 μmol/L)</td>
</tr>
<tr>
<td>urine Cu</td>
<td>83 μg/dL (13.0 μmol/L)</td>
<td>&lt;40 μg/dL (&lt;63 μmol/L)</td>
</tr>
</tbody>
</table>

This is most consistent with:

- a. normal copper levels
- b. Wilms tumor
- c. Wilson disease
- d. Addison disease

272 An active metabolite of amitriptyline is:

- a. nortriptyline
- b. protriptyline
- c. butriptyline
- d. norbutriptyline

273 Phenobarbital is a metabolite of:

- a. primidone
- b. phenytoin
- c. amobarbital
- d. secobarbital

274 Testing for the diagnosis of lead poisoning should include:

- a. erythrocyte protoporphyrin (EPP)
- b. urine delta-aminolevulinic acid
- c. whole blood lead
- d. zinc protoporphyrin (ZPP)

**Quality Assessment**

275 Blood received in the laboratory for blood gas analysis must meet which of the following requirements?

- a. on ice, thin fibrin strands only, no air bubbles
- b. on ice, no clots, fewer than 4 air bubbles
- c. on ice, no clots, no air bubbles
- d. room temperature, no clots, no air bubbles

276 After a difficult venipuncture requiring prolonged application of the tourniquet, the serum K⁺ was found to be 6.8 mEq/L (6.8 mmol/L). The best course of action is to:

- a. repeat the test using the same specimen
- b. adjust the value based on the current serum Na⁺
- c. repeat the test using freshly drawn serum
- d. cancel the test
Serum from a patient with metastatic carcinoma of the prostate was separated from the clot and stored at room temperature. The following results were obtained:

<table>
<thead>
<tr>
<th>Patient value</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca(^{++})</td>
<td>10.8 mg/dL (2.7 mmol/L)</td>
</tr>
<tr>
<td>LD</td>
<td>420 U/L</td>
</tr>
<tr>
<td>acid phosphatase</td>
<td>0.1 U/L</td>
</tr>
</tbody>
</table>

The technician should repeat the:
- a. LD using diluted serum
- b. acid phosphatase with freshly drawn serum
- c. LD with fresh serum
- d. tests using plasma

A lipemic serum is separated and frozen at -20°C for assay at a later date. One week later, prior to performing an assay for triglycerides, the specimen should be:
- a. warmed to 37°C and mixed thoroughly
- b. warmed to 15°C and centrifuged
- c. transferred to a glycerated test tube
- d. discarded and a new specimen obtained

The different water content of erythrocytes and plasma makes true glucose concentrations in whole blood a function of the:
- a. hematocrit
- b. leukocyte count
- c. erythrocyte count
- d. erythrocyte indices

In a specimen collected for plasma glucose analysis, sodium fluoride:
- a. serves as a coenzyme of hexokinase
- b. prevents reactivity of non-glucose reducing substances
- c. precipitates proteins
- d. inhibits glycolysis

As part of a hypetlipidemia screening program, the following results were obtained on a 25-year-old woman 6 hours after eating:
- triglycerides: 260 mg/dL (2.86 mmol/L)
- cholesterol: 120 mg/dL (3.12 mmol/L)

Which of the following is the best interpretation of these results?
- a. both results are normal, and not affected by the recent meal
- b. cholesterol is normal, but triglycerides are elevated, which may be attributed to the recent meal
- c. both results are elevated, indicating a metabolic problem in addition to the nonfasting state
- d. both results are below normal despite the recent meal, indicating a metabolic problem

Blood was collected in a serum separator tube on a patient who has been fasting since midnight. The time of collection was 7 AM. The laboratory test which should be recollected is:
- a. triglycerides
- b. iron
- c. LD
- d. sodium
283 Arterial blood that is collected in a heparinized syringe but exposed to room air would be most consistent with the changes in which of the following specimens?

<table>
<thead>
<tr>
<th>Specimen</th>
<th>PO₂</th>
<th>PCO₂</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>elevated</td>
<td>decreased</td>
<td>elevated</td>
</tr>
<tr>
<td>B</td>
<td>decreased</td>
<td>elevated</td>
<td>decreased</td>
</tr>
<tr>
<td>C</td>
<td>unchanged</td>
<td>elevated</td>
<td>unchanged</td>
</tr>
<tr>
<td>D</td>
<td>decreased</td>
<td>decreased</td>
<td>decreased</td>
</tr>
</tbody>
</table>

- a specimen A
- b specimen B
- c specimen C
- d specimen D

284 Specimens for blood gas determination should be drawn into a syringe containing:

- a no preservative
- b heparin
- c EDTA
- d oxalate

285 Unless blood gas measurements are made immediately after sampling, in vitro glycolysis of the blood causes a:

- a rise in pH and PCO₂
- b fall in pH and a rise in PO₂
- c rise in pH and a fall in PO₂
- d fall in pH and a rise in PCO₂

286 Which of the following serum constituents is unstable if a blood specimen is left standing at room temperature for 8 hours before processing?

- a cholesterol
- b triglyceride
- c creatinine
- d glucose

287 An arterial blood specimen submitted for blood gas analysis was obtained at 8:30 AM but was not received in the laboratory until 11 AM. The technologist should:

- a perform the test immediately upon receipt
- b perform the test only if the specimen was submitted in ice water
- c request a venous blood specimen
- d request a new arterial specimen be obtained

288 In monitoring glomerular function, which of the following tests has the highest sensitivity?

- a urine sodium
- b BUN/creatinine ratio
- c creatinine clearance
- d urea clearance

---

**Laboratory Mathematics**

289 If the pKₐ is 6.1, the CO₂ content is 25 mM/L, the salt equals the total CO₂ content minus the carbonic acid; the carbonic acid equals 0.03 \times PCO₂ and PCO₂ = 40 mm Hg, it may be concluded that:

- a pH = 6.1 + log \((40 - 0.03)/(0.03)\)
- b pH = 6.1 + log \((25 - 0.03)/(0.03)\)
- c pH = 6.1 + log \((25 - 1.2)/(1.2)\)
- d pH = 6.1 + log \((1.2)/(1.2 - 25)\)
2: Chemistry | Laboratory Mathematics

290 A 24-hour urine specimen (total volume = 1,136 mL) is submitted to the laboratory for quantitative urine protein. Calculate the amount of protein excreted per day, if the total protein is 52 mg/dL.

- a 591 mg
- b 487 mg
- c 220 mg
- d 282 mg

291 The following results were obtained:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine creatinine</td>
<td>90 mg/dL (7956 μmol/L)</td>
</tr>
<tr>
<td>Serum creatinine</td>
<td>0.90 mg/dL (79.6 μmol/L)</td>
</tr>
<tr>
<td>Patient's total body surface</td>
<td>1.73 m² (average = 1.73 m²)</td>
</tr>
<tr>
<td>Total urine volume in 24 hours</td>
<td>1500 mL</td>
</tr>
</tbody>
</table>

Given the above data, the patient’s creatinine clearance, in mL/min, is:

- a 104
- b 124
- c 144
- d 150

292 A 45-year-old male of average height and weight was admitted to the hospital for renal function studies. He had the following lab results:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine creatinine</td>
<td>120 mg/dL (10680 μmol/L)</td>
</tr>
<tr>
<td>Serum creatinine</td>
<td>1.5 mg/dL (132.6 μmol/L)</td>
</tr>
<tr>
<td>Total urine volume in 24 hours</td>
<td>1800 mL</td>
</tr>
</tbody>
</table>

Calculate the creatinine clearance for this patient in mL/min.

- a 100
- b 144
- c 156
- d 225

293 One international unit of enzyme activity is the amount of enzyme that will, under specified reaction conditions of substrate concentration, pH and temperature, cause utilization of substrate at the rate of:

- a 1 mol/min
- b 1 mmol/min
- c 1 μmol/min
- d 1 nmol/min

294 The bicarbonate and carbonic acid ratio is calculated from an equation by:

- a Siggaard-Andersen
- b Gibbs-Donnan
- c Natelson
- d Henderson-Hasselbalch

295 $^{125}$I has a physical half-life of 60.0 days. A sample tested today had activity of 10,000 CPM/mL. How many days from today will the count be 1250 CPM/mL?

- a 60
- b 180
- c 240
- d 1250
In spectrophotometric determination, which of the following is the formula for calculating the absorbance of a solution?

- (absorptivity × light path)/concentration
- (absorptivity × concentration)/light path
- absorptivity × light path × concentration
- (light path × concentration)/absorptivity

Which of the following is the formula for calculating absorbance given the percent transmittance (%T) of a solution?

- 1 - log(%T)
- log(%T)÷2
- 2 × log(%T)
- 2 - log(%T)

Which of the following is the Henderson-Hasselbalch equation?

- \( pK_a = pH + \log([\text{acid}]/[\text{salt}]) \)
- \( pK_a = pH + \log([\text{salt}]/[\text{acid}]) \)
- \( pH = pK_a + \log([\text{acid}]/[\text{salt}]) \)
- \( pH = pK_a + \log([\text{salt}]/[\text{acid}]) \)

The creatinine clearance (mL/min) is equal to:

- urinary creatinine (mg/L) ÷ [volume of urine (mL/min) × plasma creatinine (mg/L)]
- [urinary creatinine (mg/L) × volume (mL/min)] + plasma creatinine (mg/L)
- [urinary creatinine (mg/L) ÷ [volume of urine (mL/hour) × plasma creatinine (mg/L)] + plasma creatinine (mg/L)
- [urinary creatinine (mg/L) × volume (mL/hour)] + plasma creatinine (mg/L)

An adult diabetic with renal complications has the following results:

- sodium: 133 mEq/L (133 mmol/L)
- glucose: 487 mg/dL (26.8 mmol/L)
- BUN: 84 mg/dL (30.0 mmol/L)
- creatinine: 5 mg/dL (442.0 μmol/L)

On the basis of these results, the calculated serum osmolality is:

- 266 mOsm/kg
- 290 mOsm/kg
- 304 mOsm/kg
- 709 mOsm/kg
Refer to the following illustration:

The above figure shows the reciprocal of the measured velocity of an enzyme reaction plotted against the reciprocal of the substrate concentration.

True statements about this figure include:

a. the intercept of the line on the abscissa (x-axis) can be used to calculate the \( V_{max} \)

b. the straight line indicates that the enzyme reaction proceeds according to zero order kinetics

c. the intercept on the abscissa (x-axis) can be used to calculate the Michaelis-Menten constant

d. the fact that the substrate concentration is plotted on both sides of the zero point indicates that the reaction is reversible

The following results were obtained in a creatinine clearance evaluation:

- urine concentration: 84 mg/dL
- urine volume: 1,440 mL/24 hr
- serum concentration: 1.4 mg/dL
- body surface area: 1.60 m² (average = 1.73 m²)

The creatinine clearance in mL/min is:

a. 6
b. 22
c. 60
d. 65

In the International System of Units, serum urea is expressed in millimoles per liter.

- urea: \( \text{NH}_2\text{CONH}_2 \)
- atomic weight: \( N = 14, C = 12, O = 16, H = 1 \)

A serum urea nitrogen concentration of 28 mg/dL would be equivalent to what concentration of urea?

a. 4.7 mEq/L
b. 5.0 mEq/L
c. 10.0 mEq/L
d. 20.0 mEq/L

The urea nitrogen concentration of a serum sample was measured to be 15 mg/dL.

- urea: \( \text{NH}_2\text{CONH}_2 \)
- atomic weight: \( N = 14, C = 12, O = 16, H = 1 \)

The urea concentration of the same sample, in mg/dL, is:

a. 15
b. 24
c. 32
d. 40
The osmol gap is defined as measured Osm/kg minus the calculated Osm/kg. Normally, the osmol gap is less than:

- a 0
- b 2
- c 4
- d 6

Normally the bicarbonate concentration is about 24 mEq/L and the carbonic acid concentration is about 1.2; $pK = 6.1$, log 20 = 1.3. Using the equation $pH = pK + \log [\text{salt}]/[\text{acid}]$, calculate the pH.

- a 7.28
- b 7.38
- c 7.40
- d 7.42

**Instrumentation**

Stray light can be detected in a spectrophotometer by utilizing a:

- a mercury vapor lamp
- b holmium oxide glass
- c potassium dichromate solution
- d sharp cutoff filter

In the atomic absorption method for calcium, lanthanum is used:

- a as an internal standard
- b to bind calcium
- c to eliminate protein interference
- d to prevent phosphate interference

Which of the following methods is susceptible to the solvent displacing effect that results in falsely decreased electrolyte values?

- a indirect ion-selective electrodes
- b direct ion-selective electrodes
- c spectrophotometric
- d fluorescence

Upon development of a thin-layer chromatogram for drug analysis all drug spots (including the standards) had migrated with the solvent front. The most probable cause for this would be:

- a environmental temperature too warm
- b incorrect aqueous to nonaqueous solvent mixture
- c too much sample applied
- d chromatogram dried too quickly

To detect barbiturate abuse when analyzing urine specimens, immunoassay is the method of choice for screening. The method of choice for confirmation is:

- a nephelometry
- b thin-layer chromatography
- c gas chromatography/mass spectrometry
- d ultraviolet absorption spectroscopy

Reverse phase high-performance liquid chromatography is being increasingly utilized in therapeutic drug monitoring. The term reverse phase implies that the column eluant is:

- a pumped up the column
- b more polar than the stationary phase
- c always nonpolar
- d less polar than the stationary phase
313 When separating serum proteins by cellulose acetate electrophoresis, using Veronal™ buffer at pH 8.6, beta globulin migrates:
   a faster than albumin  
   b slower than gamma globulin  
   c faster than gamma globulin  
   d faster than alpha-2 globulin

314 Hemoglobin S can be separated from hemoglobin D by which of the following methods?
   a agar gel electrophoresis at pH 5.9  
   b thin-layer chromatography  
   c alkali denaturation  
   d ammonium precipitation

315 What is the proper pH for the buffered solution used to perform serum protein electrophoresis?
   a 5.6  
   b 7.6  
   c 8.6  
   d 9.6

316 The buffer pH most effective at allowing amphoteric proteins to migrate toward the cathode in an electrophoretic system would be:
   a 4.5  
   b 7.5  
   c 8.6  
   d 9.5

317 On electrophoresis, transient bisalbuminemia or a grossly widened albumin zone is associated with:
   a dirty applicators  
   b presence of therapeutic drugs in serum sample  
   c endosmosis  
   d prestaining with tracer dye

318 Which of the following serum proteins migrate with the beta-globulins on cellulose acetate at pH 8.6?
   a ceruloplasmin  
   b hemoglobin  
   c haptoglobin  
   d C3 component of complement

319 An electrode has a silver/silver chloride anode and a platinum wire cathode. It is suspended in KCl solution and separated from the blood to be analyzed by a selectively permeable membrane. Such an electrode is used to measure which of the following?
   a pH  
   b PCO₂  
   c PO₂  
   d HCO₃

320 Hydrogen ion concentration (pH) in blood is usually determined by means of which of the following electrodes?
   a silver  
   b glass  
   c platinum  
   d platinum-lactate
321 An automated method for measuring chloride which generates silver ions in the reaction is:
   a coulometry
   b mass spectroscopy
   c chromatography
   d polarography

322 Coulometry is often used to measure:
   a chloride in sweat
   b the pH in saliva
   c bicarbonate in urine
   d ammonia in plasma

323 In a pH meter reference electrodes may include:
   a silver-silver chloride
   b quinhydrone
   c hydroxide
   d hydrogen

324 Amperometry is the principle of the:
   a PCO₂ electrode
   b PO₂ electrode
   c pH electrode
   d Ionized calcium electrode

325 Most automated blood gas analyzers directly measure:
   a pH, HCO₃ and % O₂ saturation
   b pH, PCO₂ and PO₂
   c HCO₃, PCO₂ and PO₂
   d pH, PO₂ and % O₂ saturation

326 Blood PCO₂ may be measured by:
   a direct colorimetric measurement of dissolved CO₂
   b a self-contained potentiometric electrode
   c measurement of CO₂-saturated hemoglobin
   d measurement of CO₂ consumed at the cathode

327 Valinomycin enhances the selectivity of the electrode used to quantitate:
   a sodium
   b chloride
   c potassium
   d calcium

328 Which blood gas electrode is composed of silver/silver chloride reference electrode and glass?
   a PO₂
   b pH
   c PCO₂
   d HCO₃

329 Most chemical methods for determining total protein utilize which of the following reactions?
   a molybdenum blue
   b ferri-ferrocyanide
   c resorcinol-HCl
   d biuret
330  Brom cresol purple at a pH of 5.2 is used in a colorimetric method to measure:
   a  albumin
   b  globulin
   c  Bence Jones protein
   d  immunoprotein

331  Magnesium carbonate is added in an iron binding capacity determination in order to:
   a  allow color to develop
   b  precipitate protein
   c  bind with hemoglobin iron
   d  remove excess unbound iron

332  The most specific method for the assay of glucose utilizes:
   a  hexokinase
   b  glucose oxidase
   c  glucose-6-phosphatase
   d  glucose dehydrogenase

333  Which of the following would be an example of a glucose-specific colorimetric method?
   a  alkaline ferricyanide
   b  glucose oxidase
   c  hexokinase
   d  O-toluidine

334  Increased concentrations of ascorbic acid inhibit chromogen production in which of the following glucose methods?
   a  ferricyanide
   b  ortho-toluidine
   c  glucose oxidase (peroxidase)
   d  hexokinase

335  In the hexokinase method for glucose determination, the actual end product measured is the:
   a  amount of hydrogen peroxide produced
   b  NADH produced from the reduction of NAD
   c  amount of glucose combined with brom cresol purple
   d  condensation of glucose with an aromatic amine

336  Which of the following calcium procedures utilizes lanthanum chloride to eliminate interfering substances?
   a  o-cresolphthalein complexone
   b  precipitation with chloranilic acid
   c  chelation with EDTA
   d  atomic absorption spectrophotometry

337  Before unconjugated bilirubin can react with Ehrlich diazo reagent, which of the following must be added?
   a  acetone
   b  ether
   c  distilled water
   d  caffeine

338  The most widely used methods for bilirubin measurement are those based on the:
   a  Jaffe reaction
   b  Schales and Schales method
   c  8-hydroxyquinoline reaction
   d  Jendrassik-Grof method
339 In the Malloy and Evelyn method for the determination of bilirubin, the reagent that is reacted with bilirubin to form a purple azobilirubin is:

- a) dilute sulfuric acid
- b) diazonium sulfate
- c) sulfobromophthalein
- d) diazotized sulfanilic acid

340 In the Jendrassik-Grof method for the determination of serum bilirubin concentration, quantitation is obtained by measuring the green color of:

- a) azobilirubin
- b) bilirubin glucuronide
- c) urobilin
- d) urobilinogen

341 In the Jendrassik-Grof reaction for total bilirubin, bilirubin reacts with diazotized sulfanilic acid to form:

- a) diazo bilirubin
- b) biliverdin
- c) azobilirubin
- d) bilirubin glucuronide

342 In the assay of lactate dehydrogenase, which of the following products is actually measured?

- a) NADH
- b) ATP
- c) lactic acid
- d) pyruvic acid

343 In the assay of lactate dehydrogenase (LD), the reaction is dependent upon which of the following coenzyme systems?

- a) NAD/NADH
- b) ATP/ADP
- c) Fe²⁺/Fe³⁺
- d) Cu/Cu²⁺

344 Refer to the following illustration:

![Graph showing absorbance vs. time](image)

This illustration represents the change in absorbance at 340 nm over a period of 8 minutes in an assay for lactate dehydrogenase.

True statements about this figure include:

- a) the reaction follows zero order kinetics between 5 and 8 minutes
- b) the reaction is proceeding from lactate to pyruvate
- c) nonlinearity after 6 minutes is due to substrate exhaustion
- d) the change in absorbance is due to reduction of NAD to NADH
In competitive inhibition of an enzyme reaction, the:

a. inhibitor binds to the enzyme at the same site as does the substrate
b. inhibitor often has a chemical structure different to that of the substrate
c. activity of the reaction can be decreased by increasing the concentration of the substrate
d. activity of the reaction can be increased by decreasing the temperature

Refer to the following illustration:

The figure above shows the reciprocal of the measured velocity of an enzyme reaction plotted against the reciprocal of the substrate concentration. True statements about this figure include:

a. the intercept of the line on the ordinate (y-axis) can be used to calculate the $V_{max}$
b. the straight line indicates that the enzyme reaction proceeds according to zero order kinetics
c. the intercept on the ordinate (y-axis) can be used to calculate the Michaelis-Menten constant
d. the fact the substrate concentration is plotted on both sides of the zero point indicates that the reaction is reversible

The International Federation for Clinical Chemistry (IFCC) recommends the use of methods such as the Bessey-Lowry-Brock method for determining alkaline phosphatase activity. The substrate used in this type of method is:

a. monophosphate
b. phenylphosphate
c. disodium phenylphosphate
d. para-nitrophenylphosphate

The illustration below represents a Lineweaver-Burk plot of $1/v$ vs $1/[S]$ in an enzyme reaction and the following assumptions should be made:

The enzyme concentration was the same for reactions A and B.
The substrate concentration was in excess for reactions A and B.
Reaction A occurred under ideal conditions.

Which of the following statements about reaction B is true?

a. it illustrates noncompetitive inhibition
b. it illustrates competitive inhibition
c. it illustrates neither competitive nor noncompetitive inhibition
d. it could be the result of heavy metal contamination
349 Which of the following is a glycolytic enzyme that catalyzes the cleavage of fructose-1, 6-diphosphate to glyceraldehyde-3-phosphate and dihydroxyacetone phosphate?

- a aldolase
- b phosphofructokinase
- c pyruvate kinase
- d glucose-6-phosphate dehydrogenase

350 The substance that is measured to estimate the serum concentration of triglycerides by most methods is:

- a phospholipids
- b glycerol
- c fatty acids
- d pre-beta lipoprotein

351 Which of the following methods for quantitation of high-density lipoprotein is most suited for clinical laboratory use?

- a Gomori procedure
- b homogeneous
- c column chromatography
- d agarose gel electrophoresis

352 A chemiluminescent EIA:

- a measures absorption of light
- b is less sensitive than radioisotopic reactions
- c is monitored by the use of a gamma counter
- d is quantitated by the amount of light produced by the reaction

353 The osmolality of a urine or serum specimen is measured by a change in the:

- a freezing point
- b sedimentation point
- c midpoint
- d osmotic pressure

354 Which of the following applies to cryoscopic osmometry?

- a temperature at equilibrium is a function of the number of particles in solution
- b temperature plateau for a solution is horizontal
- c freezing point of a sample is absolute
- d initial freezing of a sample produces an immediate solid state

355 Assay of transketolase activity in blood is used to detect deficiency of:

- a thiamine
- b folic acid
- c ascorbic acid
- d riboflavin

356 In amniotic fluid, the procedure used to detect Rh isosensitization is:

- a human amniotic placental lactogen (HPL)
- b alpha-fetoprotein
- c measurement of absorbance at 450 nm
- d creatinine
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
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<td>117 b</td>
<td>175 a</td>
<td>233 b</td>
<td>291 a</td>
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<tr>
<td>2 c</td>
<td>60 b</td>
<td>118 b</td>
<td>176 d</td>
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<td>292 a</td>
<td>350 b</td>
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<td>3 a</td>
<td>61 c</td>
<td>119 c</td>
<td>177 c</td>
<td>235 d</td>
<td>293 c</td>
<td>351 b</td>
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</tr>
<tr>
<td>4 b</td>
<td>62 c</td>
<td>120 d</td>
<td>178 a</td>
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<td>294 d</td>
<td>352 d</td>
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<tr>
<td>5 b</td>
<td>63 b</td>
<td>121 b</td>
<td>179 c</td>
<td>237 d</td>
<td>295 b</td>
<td>353 a</td>
<td></td>
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<td>64 b</td>
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<td>180 d</td>
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<td>7 b</td>
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<td>260 c</td>
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<tr>
<td>29 a</td>
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1. d Diagnosis of hypoglycemia in adults.
   [Tietz 2006, p864]
2. c Body fluid glucose reference ranges.
   [Tietz 2006, pp871-872]
3. a GTT diet preparation.
   [Tietz 2006, p860]
4. b Normal 2-hour postprandial value.
   [Tietz 2006, p859]
5. b Ratio of CSF glucose to blood glucose.
   [Tietz 2006, pp871-872]
6. c Use of partial GTT information.
   [Tietz 2006, p859]
7. b Effect of glycolysis on glucose.
   [Tietz 2006, p869]
8. d Unequivocal diagnosis of diabetes mellitus.
   [Tietz 2006, p859]
9. b Age effect on glucose.
   [Tietz 2006, p460]
10. a Factors contributing to FBS.
    [Tietz 2006, p843]
11. d Gestational diabetes.
    [Tietz 2006, p843]
12. b Arterial vs venous glucose values.
    [Tietz 2006, p869]
13. d Definition of glycolysis.
    [Tietz 2006, p843]
14. b Diagnosis of diabetes mellitus.
    [Tietz 2006, p859]
15. c Definition of glycated hemoglobin.
    [Tietz 2006, p879]
16. a Average glucose over time is best predictor.
    [Tietz 2006, p879]
17. c Role of fructosamine.
    [Tietz 2006, p984]
18. a Interpretation of glycated hemoglobin.
    [Tietz 2006, p879]
    [Tietz 2006, p879]
20. a Glycated hemoglobin directly related to life of RBC.
    [Tietz 2006, p880]
21. d Interference Hgb A1C.
    [Tietz 2006, p882]
22. a Acetone in carbohydrate metabolism.
    [Tietz 2006, p876]
23. a Copper reduction reaction detects many reducing substances.
    [Bishop 2005, p775]
24. d Products of glycolysis.
    [Tietz 2006, p842]
25. a Diagnosis of lactase deficiency.
    [Tietz 2006, p1863]

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26. a Reduced excretion of acids.
    [Tietz 2006, p1768]
27. a Excessive loss of bicarbonate.
    [Tietz 2006, p1768]
28. c Diseases causing respiratory acidosis.
    [Tietz 2006, p1774]
29. a Blood gas instrumentation.
    [Tietz 2006, p1019]
30. a Diseases causing respiratory acidosis.
    [Tietz 2006, p1774]
31. b Normal ratio bicarbonate/carbonic acid.
    [Tietz 2006, pp1759-1760]
32. c Arterial pH reference range.
    [Tietz 2006, p2289]
33. a Interpretation of metabolic acidosis.
    [Tietz 2006, p1772]
34. a HCO₃⁻ and TCO₂ in metabolic alkalosis.
    [Tietz 2006, p1774]
35. d Levels of CO₂ and pH in metabolic alkalosis.
    [Tietz 2006, p1774]
36. d Component levels in metabolic acidosis.
    [Tietz 2006, p1772]
37. a Definition of respiratory acidosis.
    [Tietz 2006, p1774]
38. d Respiratory alkalosis caused by hyperventilation.
    [Tietz 2006, p1775]
39. c Chemical cause of alkalosis and acidosis.
    [Tietz 2006, p1760]
40. d Blood gas sample conditions.
    [Tietz 2006, p1007]
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    [Tietz 2006, p1775]
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46 c Most important buffer pair in plasma.
   [Tietz 2006, p1759]

47 c Ion selective electrode standard Na/K.
   [Tietz 2006, p986]

48 b Components of anion gap.
   [Tietz 2006, pp1768-1771]

49 c Effect of K+ from platelets on serum K.
   [Tietz 2006, p985]

50 c Major component of CO₂ in blood.
   [Tietz 2006, p1759]

51 d Anion gap, lactic acidosis.
   [Tietz 2006, pp1768-1771]

52 c Calculation of anion gap.
   [Tietz 2006, p1768]

53 d Maintenance of buffering capacity of blood.
   [Tietz 2006, p1761]

54 d Compensatory mechanism in respiratory acidosis.
   [Tietz 2006, p1774]

55 d Cation in osmotic pressure.
   [Tietz 2006, p992]

56 a Effect of hemolysis on K.
   [Tietz 2006, p985]

57 b Largest solute in osmolality.
   [Tietz 2006, p992]

58 d Reference range sweat chloride.
   [Tietz 2006, p2260]

59 a Direct ISE method.
   [Tietz 2006, pp987-988]

60 b Interferences with indirect ISE methods.
   [Tietz 2006, p987]

61 c Interferences with indirect ISE methods.
   [Tietz 2006, p987]

Proteins and Other Nitrogen-Containing Compounds

72 a Physiological feature of albumin.
   [Tietz 2006, p546]

73 b Abnormal accumulation of serous fluid due to an imbalance of fluid production and reabsorption. Fluid/serum protein ratio >0.5.
   [Henry 2006, p441]

74 d Basic principle of lab procedure timed urine.
   [Kaplan 2003, p1098]

75 b Spectral interference.
   [Henry 2006, p428]

76 b Principle of protein electrophoresis.
   [Kaplan 2003, pp203-206]

77 a Principle of protein electrophoresis.
   [Tietz 2006, p548]

78 b Concentration of albumin in serum.
   [Kaplan 2003, p214]

79 c Principle of biuret reaction.
   [Tietz 2006, p586]

80 b Principle of protein electrophoresis.
   [Kaplan 2003, p214]
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81 c Principle of electrophoresis on cellulose acetate.
   [Kaplan 2003, p204]

82 a Separation based on charge.
   [Kaplan 2003, p204]

83 a Biochemistry and structure of amino acids.
   [Tietz 2006, p534]

84 c Abnormal metabolism of amino acids.
   [Tietz 2006, p534]

85 d Loss of normal physiologic fluid balance.
   [Henry 2006, p236]

86 a A ratio and proportion procedure is most useful for calculations in which concentrations are not changed, as in this case. Set up a ratio of total area (180) to gamma globulin area (30) in units, and total protein content (6.5) to gamma globulin content (x) in g/dL. Solve for x.
   [Campbell 1997, p126]

87 d Elevated polyclonal gamma-globulins with beta-gamma bridging due to increased IgA.
   [Henry 2006, p241]

88 c Due to loss of albumin in nephrotic syndrome, increased alpha-2 is a compensatory mechanism.
   [Henry 2006, p237]

89 d Clinical correlation, deficiency of proteinase inhibitor.
   [Henry 2006, p236]

90 c Abnormal protein of a malignant plasma cell.
   [Henry 2006, p241]

91 a Abnormal liver function.
   [Henry 2006, p241]

92 d Physical-chemical property.
   [Henry 2006, p400]

93 b Anticoagulant prevents clotting.
   [Henry 2006, p242]

94 c Effect of charge on cellulose acetate.
   [Kaplan 2003, p206]

95 b Acute phase reactants.
   [Henry 2006, p241]

96 c Immunoglobulin response in inflammation.
   [Henry 2006, p241]

97 b Clinical correlation, autoimmune immunoglobulin G.
   [Henry 2006, p242]

98 c Monoclonal free kappa or lambda light chains.
   [Henry 2006, p400]

99 c Transport function of transferrin.
   [Kaplan 2003, p662]

100 d Principle of method of analysis.
   [Tietz 2006, p1188]

101 d Diurnal variation of iron metabolism.
   [Kaplan 2003, p662]

102 c Ineffective erythropoiesis, high iron turnover.
   [Tietz 2006, p1190]

103 b Features of iron deficiency anemia.
   [Tietz 2006, p1190]

104 d Features of iron overload hemochromatosis.
   [Tietz 2006, p1190]

105 c Specimen requirements for analyte stability.
   [Bishop 2005, p232]

106 d Specimen requirements for analyte stability.
   [Bishop 2005, p232]

107 a Hyperammonemina to detect encephalopathy.
   [Henry 2006, p266]

108 b Creatinine measurement. Kidney function test.
   [Tietz 2006, p798]

109 a Dilutions. Laboratory calculation.
   [Bishop 2005, p23]

110 d Correlation of disease and test result.
    [Kaplan 2003, p448]

111 c Metabolic product of protein catabolism.
    [Tietz 2006, p801]

112 d Description of the Jaffe reaction for creatinine.
    [Tietz 2006, p798]

113 d Glomerular filtration rate is estimated by filtration markers such as creatinine clearance.
    [Tietz 2006, p822]

114 c Abnormal results correlate with abnormal kidney function.
    [Tietz 2006, pp801-803]

115 b Maternal urine instead of amniotic fluid.
    [Bishop 2005, p556]

116 d Metabolism of purine bases.
    [Bishop 2005, p494]
2: Chemistry | Heme Derivatives

117 Retinol is one of the 3 biologically active forms of fat-soluble vitamin A.  
[Kaplan 2003, p570]

118 Troponin complex (TIC triple complex) consists of T, I and C.  
[Kaplan 2003, pp569-570]

119 Acute phase protein increased in inflammation.  
[Bishop 2005, p198]

120 Oligoclonal proteins are produced in multiple sclerosis and other demyelinating diseases.  
[Bishop 2005, p562]

121 Structural definition of a peptide bond.  
[Kaplan 2003, p1027]

122 Function of ceruloplasmin.  
[Bishop 2005, p196]

123 Alpha-fetoprotein is the embryonic form of albumin.  
[Kaplan 2003, p934]

124 Normal CSF includes prealbumin, the fraction at 4.5%.  
[Henry 2006, p1415]

125 Other distractors are causes of B12 deficiency.  
[Tietz 2006, p1105]

126 Biochemistry of absorption.  
[Tietz 2006, p1101]

127 Correlation of disease and prenatal screening test.  
[Kaplan 2003, p934]

133 Light-exposed bilirubin is oxidized (structurally altered).  
[Bishop 2005, p483]

134 Biochemical pathway of bilirubin.  
[Tietz 2006, p1195]

135 Principle of diazo reaction with unconjugated bilirubin.  
[Tietz 2006, p1196]

136 Total bilirubin = (direct) conjugated bilirubin + (indirect) unconjugated bilirubin 3.1 – 2.0 = 1.1.  
[Tietz 2006, p1196]

137 Principle of diazo reaction with conjugated bilirubin.  
[Tietz 2006, p1197]

138 Light-exposed bilirubin is oxidized (structurally altered).  
[Bishop 2005, p483]

139 Light-exposed bilirubin is oxidized (structurally altered).  
[Bishop 2005, p483]

140 Metabolism of bilirubin in the hepatocytes.  
[Tietz 2006, p1195]

141 Intrahepatic biliary atresia; conjugated hyperbilirubinemia.  
[Tietz 2006, p1201]

142 Definition of kernicterus.  
[Tietz 2006, p1201]

143 Correlation of disorder and abnormal metabolism of bilirubin.  
[Tietz 2006, p1199]

144 Hepatocellular disorder and highly elevated AST.  
[Henry 2006, pp273-275]

145 Post-hepatic biliary obstruction; increased alkaline phosphatase.  
[Henry 2006, p275]

146 Bleeding from upper GI.  
[Henry 2006, p272]

147 Bile pigments (uro-, meso-, stercobilin) in feces.  
[Tietz 2006, p1195]

148 Correlation of disorder and high RBC zinc protoporphyrin.  
[Kaplan 2003, p669]

149 Normal Hgb is changed to abnormal derivative CO-Hgb.  
[Tietz 2006, p1296]

Heme Derivatives

128 Principle of the test reaction.  
[Kaplan 2003, p536]

129 Hemoglobin metabolism.  
[Kaplan 2003, p497]

130 Comparative mobilities due to structures of Hgb variants.  
[Henry 2006, p524]

131 Comparative mobilities due to structures of Hgb variants.  
[Henry 2006, p522]

132 Physical-chemical property of Hgb F.  
[Henry 2006, p521]

134 Biochemical pathway of bilirubin.  
[Tietz 2006, p1195]

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148 Correlation of disorder and high RBC zinc protoporphyrin.  
[Kaplan 2003, p669]

149 Normal Hgb is changed to abnormal derivative CO-Hgb.  
[Tietz 2006, p1296]
150 c CO prevents heme iron from binding with oxygen.
[Tietz 2006, p1296]

151 b Deficiency of ALA synthase which catalyzes the 1st step of porphyrin synthesis.
[Tietz 2006, p1215]

152 c Rapid initial screening should precede complex testing.
[Tietz 2006, p1224]

153 b Other distractors are not enzymes affected by lead.
[Tietz 2006, p1211]

154 c Haptoglobin phenotyping for rare deficiency states.
[Tietz 2006, p561]

**Enzymes**

155 d There is an increase in the serum levels of amylase and lipase in acute pancreatitis. However, the elevated level of lipase persists longer than amylase. Elevated levels of lipase and amylase are seen in other intraabdominal conditions, but the frequency of elevations is less with lipase than amylase.
[Bishop 2005, pp256-258]

156 a Amylase and lipase are hydrolases involved in the breakdown of starch and glycogen, and lipid metabolism, respectively. Both enzymes are primarily located in the pancreas. Disorders of the pancreas are characterized by elevated levels of the enzymes. 5'-NT, GGT, AST and LD are elevated in liver and hepatobiliary diseases.
[Bishop 2005, pp256-258]

157 b In the amylolastic, saccharogenic and chromogenic methods for measurement of amylase, the substrate, starch is converted to glucose and maltose.
[Bishop 2005, p257]

158 b Macroamylasemia is an asymptomatic condition which results when the amylase molecule and immunoglobulins combine to form a complex. The complex is too large to be filtered across the glomerulus. Lack of renal clearance leads to an increased serum amylase and a decreased urine amylase.
[Bishop 2005, p256]

159 d Amylase is present primarily in the pancreas. Pancreatitis results in the release of the enzyme into the serum. Creatinine is a nonprotein nitrogenous substance and is measured for renal function. Beta-hydroxybutyrate is measured for diabetic acidosis and LD isoenzymes are evaluated for disorders involving the heart and liver.
[Bishop 2005, p256]

160 a Aspartate aminotransferase (AST) is involved in the transfer of an amino group between aspartate and alpha-keto acids. AST is present in several tissues, with its highest concentrations in cardiac tissue, liver and skeletal muscle. Depending on the type of liver disease, the levels may be 100× the upper limits of normal (ULN).
[Bishop 2005, p250]

161 b Aspartate aminotransferase (AST) belongs to the class of transferase enzymes. Specifically, AST catalyzes the transfer of an amino group from aspartate to alpha-ketoglutarate forming oxaloacetate and glutamine.
[Bishop 2005, p250]

162 b The transferases, alanine aminotransferase (ALT) and AST are located primarily in the liver. Elevated serum levels of the enzymes are seen in hepatocellular disorders. The levels may be 100 times the upper limit of normal. The ALT level is usually higher than AST. Increased levels of AST are also seen in infectious mononucleosis and muscular dystrophy, but ALT is not elevated in the clinical disorders.
[Bishop 2005, pp250-251]

163 a AST and ALT levels are the highest in acute hepatocellular conditions, specifically acute viral hepatitis. The levels may be 100× the upper limit of normal. Slight increases of the aminotransferases are seen in cirrhosis and metastatic hepatic carcinoma.
[Bishop 2005, pp251, 485]

164 d In the coupled reaction of AST measurement, malate dehydrogenase catalyzes the oxidation of oxaloacetate to malate in the indicator reaction.
[Bishop 2005, p250]

165 a In acute hepatocellular disorders, the serum levels of AST and ALT can be 100× the upper limit of normal. Slight increases of the enzyme activities are seen in chronic hepatitis, hemangioma, and obstructive jaundice.
[Bishop 2005, p250, 485]
166 a Elevated serum levels of LD up to 50 times the upper limit of normal are seen with pernicious anemia. The ineffective erythropoiesis results in the release of large quantities of LD1 and LD2. Increased levels of LD1 and LD2 may be seen in renal disease, but the increase is not as great as for pernicious anemia. Slight increases of LD3 are seen in pulmonary conditions and pancreatitis.
[Bishop 2005, p249]

167 d Creatine kinase (CK) catalyzes the reversible phosphorylation of creatine. The highest levels of the enzyme are found in skeletal muscle, heart muscle and brain tissue. Increased serum enzyme activity is present in diseases involving the listed muscles and tissue. Lipase is measured for acute pancreatitis; the transaminase and lactate dehydrogenase (LD) are not markedly increased in muscular dystrophy.
[Bishop 2005, p244]

168 d Lactate dehydrogenase (LD) catalyzes the interconversion of lactic and pyruvic acids. Electrophoretically, using agarose or cellulose acetate medium, LD can be separated into 5 isoenzymes, LD1-LD5. CK and lipase have 3 isoenzymes; AST has 2.
[Bishop 2005, pp248-249]

169 a Erythrocytes contain 150 times more LD activity than serum, mostly LD1 and LD2. Rupture of the RBC membranes as in hemolysis will elevate the serum level of the enzyme. LD5 is increased in liver disorders and drug toxicity if the liver is involved.
[Bishop 2005, p250]

170 b The 3 CK isoenzymes are CK1 or CKBB, CK2 or CKMB, CK3 or CKMM. CKMB is primarily located in myocardial tissue. Damage to the myocardial will cause an elevation of the CKMB level.
[Burtis 2001, p357]

171 b Creatine kinase (CK) is located in brain tissue and heart and skeletal muscle. Diseases involving the tissue site will increase the level of the enzyme activity. CK activity is not increased in hepatitis.
[Burtis 2001, p357]

172 a Elevations of serum LD4 and LD5 fractions are seen in liver and skeletal muscle diseases because the isoenzymes are located in the tissues. LD1 and LD2 are elevated in hemolytic anemia and myocardial infarction. Increased levels of LD3 are observed in pulmonary edema.

173 a After an acute myocardial infarction (AMI), CK activity increases 4-6 hours after the symptoms, peaks at 12-24 hours and returns to normal within 48-72 hours. AST increases 6-8 hours after the infarction. Elevated levels of LD are noted 12-24 hours after the symptoms. ALT activity does not increase with a AMI.
[Bishop 2005, pp246, 248, 250]

174 c Although, CKMB activity is more specific for the myocardium, CKMM is present in both the skeletal and heart muscles. An increase of the isoenzyme activity may occur after a AMI. Only one peak would be present for a brain tumor and muscular dystrophy; no peaks would be present for hepatitis since the liver is not a tissue source of CK.
[Burtis 2001, p689]

175 a The major LDH isoenzymes in the serum of healthy persons are LD2, accounting for 29%-39% of the total activity and LD1=14%-26% of enzyme activity. In a myocardial infarction the pattern is changed. The activity of LD1 is greater than LD2. The ratio of LD1 to LD2 is >1. The normal ratio is 0.45-0.74.
[Burtis 2001, p365]

176 d LD4 and LD5 isoenzymes are located in the liver and skeletal muscle. LD5 is the predominant fraction in these tissues. Elevated levels of LD5 are seen with intrahepatic disorders. LD1 and LD2 are elevated in hemolytic anemia and myocardial infarction. LD3 fraction is increased with a pulmonary infarction.
[Bishop 2005, pp248-249]

177 c Increased levels of aldolase and CK are seen with skeletal muscle disease. The magnitude of the elevation is dependent on the type of skeletal muscle disease.
[Burtis 2001, pp357-359]
2: Chemistry

**Enzymes**

178 **a** In the immunoinhibition technique for CKMB determination, antibodies are directed against the M and B units of the enzymes. Anti-M inhibits all M activity but not B activity. CK activity is measured before and after inhibition. The activity remaining after inhibition is a result of the B subunit for BB and MB activity.

[Burtis 2001, p361]

179 **c** Of the 3 CK isoenzymes, CKMB is located in the myocardial. The fraction is elevated with acute myocardial infarction (AMI). CKMM is elevated in acute muscular stress following strenuous exercise. CKBB is increased in brain injury.

[Burtis 2001, pp357-359]

180 **d** The LD isoenzymes as a percentage of total LD activity are LD1: 14%-26%, LD2: 29%-39%, LD3: 20%-26%, LD4: 8%-16% and LD5: 6%-16%. The scan indicates the fraction LD5 is increased. Elevated levels of LD5 are seen with viral hepatitis.


181 **b** The LD1 and LD2 fractions are increased in hemolytic anemia due to the intramedullary hemolysis. LD5 is increased with hepatic damage. LD3 may be increased with acute pancreatitis. The LD isoenzyme pattern in renal disease is very similar to a normal pattern except for the higher absolute values.

[Burtis 2001, pp362-363]

182 **a** Elevation of the levels of CK and AST is seen in muscle damage due to the crush injury to the thigh. AST levels can increase up to 4-8 times the upper limit of normal. Cerebrovascular accident and pulmonary infarction have increased CKBB levels. In acute hepatitis, the AST level may be 100 times the upper limit of normal.

[Bishop 2005, p244, 250]

183 **d** Obstructive jaundice is characterized by an increased ALP—3 times the upper limit of normal—and a marked increase in GGT. The aminotransferases are slightly elevated owing to the fact that they are sensitive for acute hepatocellular conditions.

[Bishop 2005, p252, 255]

184 **b** Chronic hepatitis is a chronic inflammation of the hepatocytes that persists for at least 6 months. The serum enzyme levels may be variable depending on the condition. ALT, AST and ALP may be increased by 2 times the upper limit of normal. GGT is slightly increased.

[Bishop 2005, pp490-493]

185 **b** The heat activation method of ALP isoenzyme separation involves heating an aliquot of the serum sample at 56°C for 10 minutes. An untreated aliquot of the sample along with the heated one are assayed for ALP activity.

[Burtis 2001, p368]

186 **d** The Regan isoenzyme is an abnormal ALP isoenzyme. The placental placental ALP has properties similar to the placental enzyme, in that it is also heat stable (65°C, 30 min). It has been detected in lung, breast, ovarian and colon cancer.

[Burtis 2001, p368]

187 **b** The major serum ALP isoenzymes are located in the liver, bone, intestine and placenta. Placenta ALP is most heat stable followed by the intestinal, liver and bone fractions in decreasing order of stability.

[Bishop 2005, p252]

188 **c** GGT levels are elevated in alcoholism. The levels may range from 2-3 times the upper limit of normal. ALT, AST, and ALP may be increased depending on the alcohol damage to the liver.

[Bishop 2005, p255]

189 **d** Isoenzymes are multiple forms of an enzyme that possess the ability to catalyze a reaction, but differ in structure. For enzymes located in many tissue sites, an increased total enzyme activity cannot be associated with a specific clinical disorder. However, since the isoenzyme fractions are located in various tissue sources, measurement of the different fractions are considered a more specific indicator of various disorders than total levels.

[Burtis 2001, pp160-161]

190 **a** The holoenzyme is the active system formed by a protein portion called the apoenzyme and a cofactor which can be an activator if inorganic and a coenzyme if organic.

[Bishop 2005, p237]
Lipids and Lipoproteins

194 d High-density lipoprotein (HDL) is the smallest and most dense lipoprotein. Its role in lipid metabolism involves removing cholesterol from the peripheral cells and transporting it to the liver for further metabolism. Because of these actions, HDL is thought to be anti-atherogenic. Increased levels of LDL, VLDL and chylomicrons are associated with atherosclerosis.

[Bishop 2005, p287]

195 d Serum HDL has been routinely measured indirectly by a 2-step procedure. Precipitation of all of the non-HDL lipoproteins with a polyanion-divalent cation combination reagent and centrifugation to obtain the supernatant containing only HDL. The cholesterol bound to HDL is measured as HDL. One challenge regarding the method has been the selection of a precipitating reagent that would precipitate the apoB containing lipoproteins. Dextran sulfate with magnesium has proven to be very effective.

[Burtis 2001, p487]

196 a In the indirect measurement of LDL using the Friedewald equation, values are needed for the total cholesterol, HDL cholesterol and triglyceride. Because LDL and HDL are measured based on their cholesterol content, it is necessary to determine the total cholesterol and HDL cholesterol using the same cholesterol procedure.

[Burtis 2001, p488]

197 c High-density lipoprotein (HDL) is the smallest and most dense of the lipoproteins. This is evidenced by its lipid content of 20% and protein concentration of 50%.

[Bishop 2005, p286]

198 a Familial hypercholesterolemia is a genetic condition characterized by elevated serum cholesterol levels. In homozygotes and heterozygotes, the elevated cholesterol is associated with an increased LDL level. The lack or deficiency of the LDL receptors prevents the metabolism of LDL cholesterol, resulting in an increased LDL level.

[Bishop 2005, p295]

199 c Atherosclerosis is characterized by a thickening and hardening of the arterial walls by cholesterol plaques in the lining of the arteries. Elevated levels of cholesterol are associated with the development of the plaques. One of the roles of LDL is to transport cholesterol esters to the cells for metabolism. Elevated LDL levels are also associated with development of atherosclerosis.

[Bishop 2005, p502]

200 c Low-density lipoprotein (LDL) transports about 70% of the total plasma cholesterol. HDL transports only 30% of the cholesterol. Chylomicrons and VLDL transport triglycerides.

[Burtis 2001, p475]

201 c Tangier disease results from a defect in the catabolism of Apo A-I, an essential apoprotein for HDL. In homozygotes, the plasma level for HDL is practically zero. The reduced HDL levels result from increased HDL catabolism.

[Burtis 2001, p483]

202 d Lipid analysis using overnight refrigeration involves incubating the sample at 4°C overnight. The chylomicrons, present as a thick homogenous cream layer, may be observed floating at the plasma surface.

[Kaplan 2003, p625]
203 b Food intake can cause a transient increase in the triglyceride level by 50%. The LDL and HDL levels may be decreased by 10%-15% depending on the fat content of the meal.
[Burtis 2001, p489]

204 b Tay-Sachs disease is a rare inherited disorder characterized by the near-total deficiency of the enzyme N-acetyl-beta-hexosaminidase A. The enzyme is responsible for the hydrolysis of the beta (1,4)-glycosidic bond between N-acetylgalactosamine and galactose in GM2 ganglioside. Neimann-Pick disease and Hurler's syndrome are lysosomal disorders as is Tay-Sachs. Phenylketonuria results from an absent enzyme, but is an inborn error of metabolism.
[Burtis 2001, pp931-932]

205 a The historical method to evaluate fetal lung maturity is the lecithin/sphingomyelin (L/S) ratio. Measurement of pulmonary surfactant is done to evaluate fetal lung maturity. Lecithin is the major component of the lung surfactant. Sphingomyelin, a non-lung phospholipid, has no role in the surfactant system. It serves as a control for the increase in lecithin that occurs around the 34-36th week of gestation. Other amniotic fluid evaluations include measurement of creatinine for fetal age; alpha-fetoprotein for neural tube disorder and absorbance at 450nm-bilirubin for fetal distress.

206 b The scan shows an increase in the phospholipids concentrations around the 34-36th week of gestation. The phospholipids are produced by the Type II cells of the alveolar of the lungs.
[Bishop 2005, p557]

207 b Mixed hyperlipoproteinaemia or type V hyperlipoproteinaemia occurs primarily in adulthood and is characterized by markedly elevated triglycerides, elevated very low-density lipoproteins (VLDL) and chylomicrons. Because of the markedly increased triglyceride level, the specimen integrity is milky, and overnight refrigeration shows a creamy layer over turbid serum due to the chylomicrons and triglycerides.
[Kaplan 2003, p623]

208 c Lipoprotein lipase hydrolyzes triglycerides and chylomicrons during normal lipid metabolism. A deficiency in lipoprotein lipase results in markedly increased serum chylomicrons and triglycerides.
[Burtis 2001, p481]

209 d In the endogenous pathway for lipid metabolism the hepatocytes can synthesize triglycerides from carbohydrates and fatty acids. The triglycerides are packaged in VLDL, and ultimately delivered to the circulation in that form. Exogenous triglycerides are transported primarily by chylomicrons. HDL transports cholesterol from peripheral cells to the liver. LDL transports cholesterol and phospholipids to peripheral cells.
[Bishop 2005, pp288-289]

210 c Elevated levels of chylomicrons in serum or plasma will result in a turbid specimen. The large size of the chylomicron will reflect the light, causing a turbid appearance.
[Bishop 2005, p286]

Endocrinology and Tumor Markers

211 b TSH produced by pituitary gland.
[Bishop 2005, p448]

212 b Increased TSH, decreased free T4 and total T4, positive microsomal Ab consistent with primary hypothyroidism.
[Bishop 2005, pp449-451]

213 d Increased TSH, decreased free T4 and total T4, symptoms of cold intolerance and hair loss are consistent with hypothyroidism.
[Bishop 2005, pp449-451]

214 c T3 is more biologically active, 80% of T4 is converted into T3.
[Bishop 2005, p446]

215 b Congenital hypothyroidism presents with very low thyroid hormones and is best confirmed by serum TSH.
[Bishop 2005, pp664-665]

216 b >99% of T3 and T4 are bound to thyroxine-binding prealbumin, thyroxine-binding globulin, and albumin.
[Bishop 2005, pp447-448]

217 b TSH is the American Thyroid Association's recommended screening test.
[Arneson 2007, p404]
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218 d Neonates are screened using total T4.
[Arneson 2007, p402]

219 d Hashimoto thyroiditis—the most common cause of hypothyroidism.
[Bishop 2005, p450-451]

220 a Age, sex, physical complaint, with elevated TSH point to primary hypothyroidism.
[Bishop 2005, p445-451]

221 b hCG is the primary marker for early pregnancy.
[Arneson 2007, p429-431]

222 b During pregnancy, the largest fraction of estrogen in urine is estriol.
[Arneson 2007, p435]

223 b hCG levels peak at 8-10 weeks after the last menstrual period (LMP).
[Arneson 2007, p431]

224 a The procedure “change in absorbance of amniotic fluid at 450 nm” used to detect hemolytic disease of newborn (HDN).
[Bishop 2005, pp555-557]

225 b Serum hCG levels peak at 8-10 weeks.
[Arneson 2007, p431]

226 a MoM calc = 34/32 = 1.06 (or < 2).
[Arneson 2007, p450]

227 b Aldosterone is a hormone produced by the adrenal cortex.
[Bishop 2005, pp414-415]

228 d All adrenal steroid hormones are enzymatically derived from cholesterol.
[Bishop 2005, p414]

229 d Testosterone is the most biologically active androgen in the embryonic stage and later effects sperm production and secondary sex characteristics.
[Bishop 2005, p436]

230 a The normal variation of serum cortisol is higher at 8 AM than 4 PM.
[Arneson 2007, p383]

231 a A deficiency of vitamin A leads to night blindness, and if prolonged total blindness.
[Bishop 2005, p620]

232 d A deficiency of thiamine (vitamin B1) known as beriberi, may be seen with chronic alcoholism in the U.S.
[Bishop 2005, p622]

233 b A deficiency of ascorbic acid (vitamin C) is called scurvy.
[Bishop 2005, p626]

234 d A deficiency of vitamin D in children leads to rickets.
[Bishop 2005, pp621-622]

235 d A deficiency of niacin may be seen with chronic alcoholism, and is known as pellagra.
[Bishop 2005, p623]

236 b Angiotensin II is a vasoconstrictor and stimulates the adrenal cortex to produce aldosterone.
[Arneson 2007, p388]

237 d Vanillylmandelic acid (VMA) is the major metabolite of epinephrine and norepinephrine. VMA is measured in a 24-hour urine.
[Arneson 2007, p396]

238 c Parathyroid hormone (PTH) and the hormone vitamin D play a dominant role in calcium regulation.
[Bishop 2005, pp458-461]

239 c 95% of congenital adrenal hyperplasia is associated with a deficiency of 21-hydroxylase. Increased 17-OH progesterone is seen if measured by the laboratory.
[Bishop 2005, pp415-416]

240 c ACTH stimulation tests, using synthetic ACTH, will differentiate primary from secondary adrenal insufficiency. Synthetic ACTH will not cause the adrenal gland to respond in primary insufficiency.
[Arneson 2007, pp384-385]

241 a The 24-hour urine free cortisol is the most sensitive and specific screen for hypercortisolism.
[Bishop 2005, p420]

242 c Following an overnight fast, a 100 gram oral glucose load will cause a large drop in serum growth hormone in a normal individual, but will not suppress in patients with acromegaly.
[Bishop 2005, p404]

243 b About 55%-60% of patients whose breast tumors demonstrate estrogen receptors (ER) respond well to endocrine therapy.
[Bishop 2005, p613]

244 c Due to circadian variation, the 24-hour UFC is an accurate measurement of active forms of cortisol.
[Bishop 2005, p420]
### TDM and Toxicology

**255** c  PSA can be elevated due to BPH.  
[Arneson 2007, p492]

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**256** a  Intestinal absorption of digoxin is variable, and tissue uptake is slow; therefore, serum levels are measured 8 hours after administration to permit tissue and serum levels to equilibrate.  
[Bishop 2005, pp577-578]

**257** c  A steady-state therapeutic drug level is achieved between 4 and 7 doses. Many variables affect when steady state is achieved.  
[Bishop 2005, p575; Arneson 2007, p506]

**258** b  Low serum protein means less of a drug is bound to protein. This may occur due to nephrotic syndrome, which causes significant protein loss and hypoalbuminemia.  
[Bishop 2005, p572]

**259** a  These drugs are not administered orally.  
[Bishop 2005, p579]

**260** c  NAPA is the active metabolite of procainamide.  
[Bishop 2005, pp578-579]

**261** d  The primary metabolite of cocaine is benzoylecgonine, which is produced by the liver and eliminated in the urine. Benzylecgonine is detected in drugs of abuse screens for cocaine.  
[Bishop 2005, pp600-601]

**262** d  11-nor-THC-COOH is the urinary metabolite of cannabinoids (marijuana and hashish).  
[Bishop 2005, p600]

**263** d  Lead interferes with heme synthesis, which on a CBC may present as a decreased hemoglobin, with basophilic stippling of the red blood cells. These findings in a child may indicate lead toxicity. Whole blood lead is the recommended test; but urine delta-aminolevulinic acid and RBC zinc protoporphyrin are also useful assays.  

**264** a  Erythrocyte zinc protoporphyrin is a useful screen for lead toxicity.  
[Bishop 2005, p594]

**265** c  Lithium (carbonate) is used to treat manic depression or bipolar disorder.  
[Bishop 2005, p581; Arneson 2007, p515]
Phenytoin (trade name Dilantin™) is an anticonvulsant therapeutic drug used to treat seizure disorders. [Bishop 2005, pp.580-588; Arneson 2007, pp.514-515]

The action of the drug theophylline is bronchodilation and smooth muscle relaxation. [Arneson 2007, p.515]

Digoxin at therapeutic serum levels (0.5-1.5 ng/mL) improves cardiac muscle contraction and rhythm. [Arneson 2007, pp.510-512]

Salicylate levels are used to determine if aspirin (acetylsalicylic acid) toxicity is present. Toxic serum or plasma levels are generally >300 µg/mL. [Arneson 2007, pp.517-518]

Lithium (carbonate) is used to treat manic depression or bipolar disorder. [Bishop 2005, p.581; Arneson 2007, p.515]

Ceruloplasmin made by the liver, is the primary serum copper-bearing protein. [Bishop 2005, p.370]

Nortryptiline is an active metabolite of amitriptyline and must be included in analysis for tricyclic antidepressants (TCAs). [Bishop 2005, p.582]

Primidone is an inactive proform of phenobarbital. [Bishop 2005, p.580; Arneson 2007, p.514]

Measurement of whole blood lead is the recommended test for children. In adults higher lead levels are significant; therefore other methods, such as erythrocyte protoporphyrin and delta-aminolevulinic acid, are acceptable for adults. [Arneson 2007, pp.188-189]

Serum for acid phosphatase measurement should not be stored at room temperature. This analyte requires special collection (citrate 10g/L) and storage (frozen) conditions to help stabilize the pH at about 6.2. [Tietz 2006, p.54]

Frozen samples should be allowed to thaw slowly at room temperature or in a 37°C water bath and should then be mixed thoroughly before analysis. [Kaplan 2003, p.78]

Water content is higher in plasma than in whole blood. [Tietz 2006, p.868]

Sodium fluoride exerts its preservative action by inhibiting the enzyme systems involved in glycolysis. [Tietz 2006, p.48]

A high-fat diet increases the serum concentrations of triglycerides. Fasting overnight for 10-14 hours is the optimal time for fasting around which to standardize blood collections, including lipids. [Tietz 2006, p.454]

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The presence or exposure of excess gas (oxygen) in the syringe used to collect blood gas specimens will cause diffusion of carbon dioxide out of the specimen, oxygen into the specimen, and an increase in pH. [Clarke 2006, p.322]

Arterial specimens are best collected anaerobically with lyophilized heparin anticoagulant in sterile syringes. [Tietz 2006, p.1007]

Failure to adequately chill blood gas specimens if not immediately analyzed will allow glucose metabolism, which increases carbon dioxide and lowers pH. [Clarke 2006, p.322]

Glucose decreases at a rate of 5%-7% per hour in whole blood at room temperature. Glycolysis will continue until the specimen is processed by centrifugation, and serum and plasma is separated from the cellular components of blood. [Clarke 2006, p.6]
287  

The use of an incorrect tube type or collection of a specimen at an inappropriate time may also require specimen recollection.  
[Clarke 2006, p8]

288  

Creatinine clearance offers the highest sensitivity in monitoring glomerular function of the tests listed.  
[Clarke 2006, p312]

Laboratory Mathematics

289  

\[ pH = 6.1 + \log(\text{salt}/\text{acid}) \]. Salt = total carbon dioxide content - carbonic acid.  
[Tietz 2006, p1022]

290  

52 mg/dL = 0.52 mg/mL. Therefore 0.52 mg/mL \times 1136 mL = 591 mg.  
[Tietz 2006, p577]

291  

Creatinine clearance = (urine creatinine \times \text{urine volume [mL/min]/serum creatinine}) \times 1.73 / \text{total body surface}.  
[Clarke 2006, p43]

292  

Creatinine clearance = (urine creatinine \times \text{urine volume [mL/min]/serum creatinine}) \times 1.73 / \text{total body surface}.  
[Clarke 2006, p45]

293  

In 1961, the enzyme commission recommended the adoption of an international unit (IU) of enzyme activity. The IU was defined as the amount of enzyme that would convert 1 \mu mol of substrate per minute under standard conditions.
1 IU = \mu mol/min.  
[Kaplan 2003, p1044]

294  

\[ pH = pK_a + \log([\text{salt}]/[\text{acid}]) \]; salt = bicarbonate; acid = carbonic acid.  
[Clarke 2006, p319]

295  

\[ t = 1.44 \times t\frac{1}{2} \times \ln(\text{original activity / remaining activity}); t\frac{1}{2} = \text{half life}. \]  
[Clarke 2006, p42]

296  

Absorbance = molar absorptivity coefficient \times \text{light path} \times \text{concentration}. Therefore molar absorptivity = absorbance / \text{light path} \times \text{concentration}.  
[Kaplan 2003, p38]

297  

Because the following relationship is true, A = light stopped and T = light passed through, A and T are inversely related. They are also logarithmically related, because the absorption of light is a logarithmic function.  
[Campbell 1997, p212]

298  

The Henderson-Hasselbalch equation describes the derivation of pH as a measure of acidity (using the acid dissociation constant, pK_a) in biological and chemical systems.  
[Clarke 2006, p319]

299  

Renal clearance tests are used to assess kidney function. Renal clearance of a substance is a rate measurement that expresses the volume of blood cleared of that substance (typically creatinine) per unit of time. The unit for the clearance is mL/min. To calculate creatinine clearance, the following information is required: Serum concentration [S], urine concentration [U] (Note: the serum and urine concentration must be in the same units, for example, mg/L or mg/dL), and volume of urine excreted per minute (V) (volume of urine collected divided by the time period in minutes). The following formula can then be used: clearance (uncorrected for body mass) = [U] \times [V]/[S].  
[Kaplan 2003, p41]

300  

Calculated osmolality (mOsm / kg) = (2 \times \text{blood urea nitrogen [mg/dL]} / 2.8) + (\text{glucose [mg/dL]} / 18).  
[Kaplan 2003, p267]

301  

Reciprocal of substrate concentration that produces 1/2 the maximal velocity (K_m) is displayed as the intercept of the x-axis on a Lineweaver-Burk transformation.  
[Kaplan 2003, p1054]

302  

Creatinine clearance = (urine creatinine \times \text{urine volume [mL/min]/serum creatinine}) \times 1.73 / \text{total body surface}.  
[Kaplan 2003, p41]

303  

The urea / nitrogen factor is 2.14. Therefore 28 mg/dL urea nitrogen = 60 mg/dL urea = 10 mEq/L urea.  
[Kaplan 2003, p36]

304  

The urea/nitrogen factor is 2.14.  
[Kaplan 2003, p36]

305  

The difference between the actual osmolality commonly measured by freezing point depression and the calculated osmolality is referred to as the osmol gap. Normally, the osmol gap is < 10 mOsm/kg.  
[Tietz 2006, p3292]
2: Chemistry | Instrumentation

306 c Given the values of bicarbonate, carbonic acid, and the pK, the pH can be easily calculated using the Henderson-Hasselbalch equation. The Henderson-Hasselbalch equation describes the derivation of pH as a measure of acidity (using the acid dissociation constant, pK_a) in biological and chemical systems.
[Kaplan 2003, p39]

Instrumentation

307 d Other distractors are methods to detect stray light.
[Kaplan 2003, p94]

308 d In calcium analysis by AAS, lanthanaum is added to bind with phosphate, thereby preventing interference by the formation of calcium phosphate.
[Bishop 2005, p98]

309 a The electrolyte exclusion effect applies only to indirect methods and is caused by the solvent displacing effect of high concentrations of lipid and protein in the sample resulting in falsely decreased values.
[Tietz 2006, p987]

310 b Principles of adsorption and selectivity in thin-layer chromatography.
[Kaplan 2003, p110]

311 c In practice, a positive screening result for barbiturates obtained by immunoassay is confirmed by gas chromatography/mass spectrometry analysis of the urine specimen.
[Tietz 2006, p1327]

312 b Retention of an analyte on a reversed-phase column depends on the relative amounts of polar and nonpolar character of the analyte. Retention on the reversed-phase packing material is favored by increased nonpolar content of the analyte, whereas residence in the mobile phase leading to early elution from the column is favored by an increased content of polar functionalities present on the analyte.
[Kaplan 2003, p137]

313 c Protein electrophoresis migration.
[Tietz 2006, p128]

314 a Separation of Hgb S from Hgb D.
[Tietz 2006, p1172]

315 c Protein electrophoresis pH.
[Tietz 2006, p584]

316 a Proteins are amphoteric substances; that is, they contain acidic and basic groups. Their overall (net) charge is highly positive at low pH values, 0 at a particular higher pH, and negative at still more alkaline pH values. At a pH of 4.5, the positively charged proteins will migrate toward the cathode in an electrophoretic system.
[Kaplan 2003, p204]

317 b Occasionally, a split albumin zone is observed in the rare benign genetically relation condition of bisalbuminemia. However, transient bisalbuminemia or a grossly widened albumin zone could be due to albumin-bound medications.
[Tietz 2006, p127]

318 d The C3 component of complement migrates with beta-globulins on electrophoresis.
[Tietz 2006, p567]

319 c PO2 electrode.
[Tietz 2006, p104]

320 b The pH electrode, a glass electrode, contains a specially designed thin piece of glass as a membrane. The glass membrane is made of silicon dioxide, added oxides and various metals. The membrane is selectively sensitive to hydrogen ions.
[Burtis 2001, p109]

321 a Coulometry is an electrochemical technique used to measure the amount of electricity passing between 2 electrodes in an electrochemical cell. An application of coulometry is the titration of chloride with silver ions generated by electrolysis from a silver wire at the anode. Polarography is also an electrochemical technique, but measures current. Mass spectroscopy and chromatography are separation techniques.
[Burtis 2001, p116]

322 a Coulometry is still used for chloride determinations in body fluids, such as sweat. However, chloride ion-selective electrodes (ISE) are commonly used today.
[Bishop 2005, p564; Arneson 2007, p118]

323 a The reference pH electrode is often constructed of Ag and AgCl.
[Bishop 2005, p102; Arneson 2007, p304]

324 b The PO2 electrode functions on the amperometric principle, which the measurement of electrical current at a constant voltage (or potential).
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325 b pH, PCO₂, and PO₂ are directly measured by modern blood gas analyzers; other parameters are calculated. [Bishop 2005, p354, Arneson 2007, p354]

326 b The PCO₂ electrode is a self-contained potentiometric cell. CO₂ gas from the sample or calibration matrix diffuses through the selective membrane and dissolves in the internal electrolyte layer. Carbonic acid is formed and dissociates, shifting the pH of the bicarbonate solution in the internal layer. This shift is related to the carbon dioxide in the sample. [Tietz 2006, p99]

327 c Analyzers fitted with ion-selective electrodes usually contain potassium electrodes with liquid ion-exchange membranes that incorporate valinomycin. Valinomycin is a neutral carrier (ionophore) that binds potassium in the center of a ring of oxygen atoms. [Clarke 2006, p100]

328 c PCO₂ electrode. [Tietz 2006, p99]

329 d Total protein method. [Tietz 2006, p587]

330 a Albumin method. [Tietz 2006, p548]

331 d The total iron binding capacity (TIBC) is the amount of iron that transferrin and other minor iron binding proteins are capable of binding. In the measure of the TIBC, the molecules are saturated with iron (since they are only 30% saturated normally). Magnesium carbonate is used to remove the excess bound by adsorption. [Bishop 2005, p369]

332 a Most specific glucose method. [Tietz 2006, p869]

333 b Other distractors are not glucose-specific methods. [Tietz 2006, p870]

334 c Ascorbic acid interferes. This is a limitation of the glucose oxidase (peroxidase) reaction. [Tietz 2006, p870]

335 b Principle of the hexokinase method. [Tietz 2006, p869]

336 d Atomic absorption spectrophotometry (AAS) measures calcium by detecting its atomic absorption by electromagnetic radiation. One limitation of this method is the nonspectral interference which occurs when phosphates are present and complex with calcium. The use of lanthanum chloride with the method has prevented the interference. Lanthanum chloride competes for the phosphate. [Burtis 2001, p73]

337 d Unconjugated bilirubin solvent. [Tietz 2006, p1196]

338 d Other distractors are not bilirubin methods. [Bishop 2005, p482]

339 d The diazo method of Malloy and Evelyn involves bilirubin reacting with diazotized sulfanilic acid to form azobilirubin. [Burtis 2001, p605]

340 a In the Jendrassik-Grof method for bilirubin measurement, the addition of caffeine plus diazotized sulfanilic acid and the serum produces azobilirubin. Ascorbic acid, alkaline tartrate and dilute HCl are added to the reaction mixture. The blue-green azobilirubin is measured. Bilirubin glucuronide, urobilin and urobilinogen are intermediaries in bilirubin metabolism. They are not measured by this method. [Burtis 2001, p605]

341 c Azobilirubin is the chromophore measured in the Jendrassik-Grof reaction. Azobilirubin is formed by bilirubin in the presence of diazotized-sulfanilic acid. [Bishop 2005, p482, Arneson 2007, p238]

342 a LDH chemical reaction. [Tietz 2006, p601]

343 a Nicotinamide adenine dinucleotide is the coenzyme system for the LD assay. NADH is the reduced form and NAD is the oxidized form. The coenzymes serve as a substrate for dehydrogenases reactions. ATP/ADP and Cu/Cu²⁺ are not coenzymes. Fe is an activator for enzymatic reactions. [Burtis 2001, p364]
344  c  In the continuous monitoring method of the measurement of LD activity, the decrease in absorbance at each time interval indicates that the product formed (substrate converted) is constant up to 6 minutes. After 6 minutes, the substrate concentration is limited, and there is a decrease in the rate of product formation as indicated by the lack of linearity.
[Burtis 2001, p170]

345  a  Competitive inhibitors bind at the active site of enzymes and compete with the substrate for binding sites.
[Kaplan 2003, p1057]

346  a  Reciprocal of the maximal velocity \( V_{\text{max}} \) can be calculated and is displayed as the intercept of the y-axis on a Lineweaver-Burk transformation.
[Kaplan 2003, p1054]

347  d  Alkaline phosphatase catalyzes the hydrolysis of para-nitrophenyl phosphate, forming phosphate and free 4-nitrophenyl (4-npp) which, under alkaline conditions, has a very intense yellow color. IFCC recommended methods use 4-npp as the substrate.
[Tietz 2006, p609]

348  b  In competitive inhibition, the binding of the substrate is affected; thus, the apparent \( K_m \) will be higher while the \( V_{\text{max}} \) remains the same.
[Kaplan 2003, p1058]

349  a  Aldolase catalyzes the splitting of fructose-1,6-diphosphate to glyceraldehyde-3-phosphate and dihydroxyacetone phosphate, an important reaction in the glycolytic breakdown of glucose to lactate.
[Tietz 2006, p603]

350  b  There are several enzymatic methods for measuring serum triglyceride. The first step of the coupled reactions involves the hydrolysis of triglyceride by lipase to produce glycerol and fatty acids. Glycerol is a reactant in one of 2 enzymatic sequences for the final measurement of triglycerides.
[Burtis 2001, p487]

351  b  High-volume HDL method.
[Tietz 2006, p945]

352  d  Chemiluminescent labels are based on the emission of light produced during a chemical reaction. These labels are very useful because they provide very low levels of detection \( (2 \times 10^{-10}\text{ mol/L}) \) with little or no background interference.
[Clarke 2006, p122]

353  a  Osmometry of serum and other body fluids is commonly measured by freezing-point depression, using a freezing point osmometer.
[Bishop 2005, pp118-119; Arneson 2007, p120]

354  a  The osmolality of a solution does not depend on the kind of particles but only on the number of particles, therefore it is called a colligative property.
[Kaplan 2003, p269]

355  a  Transketolase is decreased in thiamin deficiency. Low values of it have also been found in chronic alcoholism.
[Tietz 2006, p631]

356  c  The "optical density Delta 450" determination is a graphical calculation to estimate the amount of bilirubin in amniotic fluid. Bilirubin has a maximal absorbance at 450nm.
[Clarke 2006, p43]