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QUALIFICATION : BACHELOR of MEDICAL LABORATORY SCIENCES	
QUALIFICATION CODE: 08BMLS	**LEVEL: 6**
COURSE: CLINICAL CHEMISTRY 2B	**COURSE CODE: CLC621S**
DATE: JANUARY 2024	**SESSION: 1**
DURATION: 3 HOURS	**MARKS: 100**

SECOND OPPORTUNITY/ SUPPLEMENTARY: EXAMINATION QUESTION PAPER

EXAMINER: *MRS. CARA MIA DUNAISKI*

MODERATOR: *MRS. EDWIG SHINGENGE*

INSTRUCTIONS:

1. Answer all questions on the separate answer sheet.
2. Please write neatly and legibly.
3. Do not use the left side margin of the exam paper. This must be allowed for the examiner.
4. No books, notes and other additional aids are allowed.
5. Mark all answers clearly with their respective question numbers.

PERMISSIBLE MATERIALS:

1. Non-Programmable Calculator

ATTACHMENTS:

1. Reference values

This question paper consists of 6 pages including this front page

SECTION A: SHORT QUESTIONS [30 MARKS]

QUESTION 1: [10 MARKS]

State the principles of the following assays as used in clinical chemistry:

1.1 Electrophoresis (2)

1.2 Ion selective electrodes. (2)

1.3 Biuret test (2)

1.4 Osmometer (2)

1.5 Estimation of Low Density Lipoprotein (LDL) using the Friedewald equation (2)

QUESTION 2: [10 MARKS]

A student performed an experiment on a urea samples and obtained the following results presented in table below:

Sample	**Absorbance**
Standard (Reference range: 10.0 mmol/L)	0.45
Control (Reference range: 10.0-15.0 mmol/L)	0.52
Patient sample (Reference range: 2.5-8.3 mmol/L)	0.71

2.1 Calculate the urea concentration of the control and patient. (4)

2.2 Comment on the results of both the control and patient. (2)

2.3 Identify FOUR clinical uses of serum urea measurements. (4)

QUESTION 3: [10 MARKS]

A patient presents to the oncology ward with the following serum measurements and elevated levels IgM monoclonal antibodies:

Total protein	140 g/L (Reference range: 65-85)
Albumin	29 g/L (Reference range: 35-55)

3.1 Suggest TWO possible causes of such a presentation. (2)

3.2 Propose further testing you would perform to help in making a diagnosis. Justify your choice of test. (2)

3.3 Illustrate the expected presentation of your analysis proposed in (b). (6)

SECTION B: SHORT AND LONG QUESTIONS [70 MARKS]

QUESTION 4: [10 MARKS]

A patient's lipogram has the following results:

Total cholesterol	7.1 mmol/L
HDL cholesterol	1.1 mmol/L
Triglyceride	2.63 mmol/L

Enumerate the following (Show all working):

4.1 Calculate LDL using the Friedewald method (1 decimal place). (2)

4.2 Describe the FOUR major classes of Lipoproteins that transport hydrophobic lipid molecules in in blood plasma. (8)

QUESTION 5: [10 MARKS]

5.1 Discuss the significance of measuring serum and urine osmolality. (10)

QUESTION 6: [15 MARKS]

6.1 Using relevant examples illustrate how enzymes are used as reagents in the clinical chemistry laboratory to diagnose various disorders. (15)

QUESTION 7: [10 MARKS]

7.1 Compare and contrast the HbA1C enzymatic method with the HbA1C High Performance Liquid Chromatography (HPLC) method used to monitor diabetes. (10)

QUESTION 8: [10 MARKS]

8.1 Compare and contrast the HbA1C enzymatic method with the HbA1C High Performance Liquid Chromatography (HPLC) method used to monitor diabetes. (10)

QUESTION 9: **[15 MARKS]**

9.1 A patient presents at her Physician with general body malaise, spells of dizziness over a long period and pronounced parlour. The Physician notices that the patient generally looks unwell and collects blood samples for analysis by the Laboratory. He strongly feels the patient has anaemia of chronic disease. Identify the tests, which are likely to be performed in the clinical chemistry laboratory. State the expected results that may support the Physician's provisional diagnosis. Justify the choice of your tests and expected results. Only give relevant tests. (15)

END OF QUESTION PAPER

CLINICAL LABORATORY TESTS – REFERENCE VALUES

This table lists reference ranges (expressed in both SI units and traditional units) for the most common laboratory tests and is intended for interpretation of the results as they are provided in the examinations. **Most of the values apply to adults and where they differ for children it will be indicated.** Many important laboratory reference values are not listed here, because of the less frequent use of these tests. Such values are inserted parenthetically following the result recorded in the examination question.

Tests	SI Units	Traditional Units
Activated partial thromboplastin time (aPTT)	25-40 sec	25-40 sec
Albumin (serum)	35-50 g/L	3.5-5.0 g/dL
Amylase (serum)	25-125 IU/L	25-125 U/L
Bicarbonate (HCO_3) (serum)	23-29 mmol/L	23-29 mEq/L
Bilirubin (serum)* Neonates (conjugated)	0-10 µmol/L	0-0.6 mg/dL
(total)	1.7-180 µmol/L	1.0-10.5 mg/dL
Adults (conjugated)	0-5 µmol/L	0-0.3 mg/dL
(total)	3-22 µmol/L	0.2-1.3 mg/dL
Bleeding time (Ivy)	< 5 min	< 5 min
Calcium (serum)**		
Total	2.10-2.50 mmol/L	8.4-10.6 mg/dL
Ionized	1.15-1.35 mmol/L	4.6-5.1 mg/dL
Calcium (urine)	< 6.2 mmol/d	< 250 mg/24h
Carcinoembryonic antigen (CEA) (serum)	< 3.0 µg/L	< 3.0 ng/mL
CO_2 (total)**	22-29 mmol/L	22-29 mEq/L
Chloride (serum)	96-106 mmol/L	96-106 mEq/L
Chloride (urine) Infant	2-10 mmol/d	2-10 mEq/24h
Child	14-50 mmol/d	14-50 mEq/24h
Adults	110-250 mmol/d	110-250 mEq/24h
Cholesterol (serum)**	< 5.2 mmol/L	< 200 mg/dL
Cortisol (plasma) 8 AM	170-635 nmol/L	6-23 µg/dL
4 PM	82-413 nmol/L	3-15 µg/dL
Creatinine (serum)	50-110 µmol/L	0.6-1.2 mg/dL
Creatinine (urine) Males	8.8-17.6 mmol/d	1.0-2.0 g/24h
Females	7.0-15.8 mmol/d	0.8-1.8 g/24h
Creatine kinase (CK, CPK) - Males (race dependent)	20-215 IU/L	20-215 U/L
Females (race dependent)	20-160 IU/L	20-160 U/L
Erythrocytes (RBCs) - Children**	4.5-5.1 x 10^{12}/L	4.5-5.1 million/mm^3
Males	4.6-6.2 x 10^{12}/L	4.6-6.2 million/mm^3
Females	4.2-5.4 x 10^{12}/L	4.2-5.4 million/mm^3
Ferritin (serum)	20-200 µg/L	20-200 ng/mL
Follicle-stimulating hormone (FSH) (plasma)		
Males	1-10 IU/L	1-10 mU/mL
Females, premenopausal	20-50 IU/L	20-50 mU/mL
Females, postmenopausal	40-250 IU/L	40-250 mU/mL
Glucose (fasting) (plasma or serum)	3.9-6.1 mmol/L	70-110 mg/dL
Growth hormone (hGH) (serum, adult) fasting	0-10 µg/L	0-10 ng/mL
Hematocrit - Newborn	0.49-0.54	49-54%
Children**	0.35-0.49	35-49%
Males	0.40-0.54	40-54%
Females	0.37-0.47	37-47%
Hemoglobin (Hb) - Newborn	165-195 g/L	16.5-19.5 g/dL
Children**	112-165 g/L	11.2-16.5 g/dL
Males	140-180 g/L	14.0-18.0 g/dL
Females	120-160 g/L	12.0-16.0 g/dL
High density lipoproteins (HDL) (recommended range)	> 0.91 mmol/L	> 35 mg/dL
INR	0.9-1.1	0.9-1.1
Iron (serum) - Males	13-31 µmol/L	75-175 µg/dL
Females	5-29 µmol/L	28-162 µg/dL
Iron binding capacity (serum) (TIBC)	45-73 µmol/L	250-410 µg/dL
Lactate dehydrogenase (LDH) (serum) - Adult	45-90 IU/L	45-90 U/L
Child	60-170 IU/L	60-170 U/L
> 60 years old	55-100 IU/L	55-100 U/L

*Test values are method dependent
**Test values vary with age
***Test values are diet dependent

Tests	SI Units	Traditional Units
Leukocytes - Total	3.5-12.0 x 10^9/L	3500-12,000/mm^3
Differential: Neutrophils	3000-5800 x 10^6/L	3000-5800/mm^3
Lymphocytes	1500-3000 x 10^6/L	1500-3000/mm^3
Monocytes	300-500 x 10^6/L	300-500/mm^3
Eosinophils	50-250 x 10^6/L	50-250/mm^3
Basophils	15-50 x 10^6/L	15-50/mm^3
Low density lipoproteins (LDL) (recommended range)	< 3.4 mmol/L	< 130 mg/dL
Luteinizing hormone (LH) (serum) – Males	1-9 IU/L	1-9 IU/L
Females (follicular)	2-10 IU/L	2-10 IU/L
(mid-cycle)	15-65 IU/L	15-65 IU/L
(luteal)	1-12 IU/L	1-12 IU/L
(postmenopausal)	12-65 IU/L	12-65 IU/L
Magnesium (serum)	0.65-1.05 mmol/L	1.3-2.1 mg/dL
Magnesium (urine)	3.0-4.3 mmol/d	6.0-8.5 mEq/24h
Mean corpuscular volume (MCV)	76-100 fL	76-100 μm^3
Osmolality (serum)	285-295 mmol/kg	285-295 mOsm/kg
Osmolality (urine)	38-1400 mmol/kg	38-1400 mOsm/kg
Oxygen (arterial saturation)	94-99%	94-99%
Parathyroid hormone (PTH)	1.4-6.8 pmol/L	13.2-64.1 pg/mL
Partial thromboplastin time (PTT)	See aPTT	See aPTT
pCO_2 (arterial)	35-45 mm Hg	35-45 mm Hg
pH (arterial)	7.35-7.45	7.35-7.45
Phosphatase, alkaline (serum)	40-160 IU/L	40-160 U/L
Phosphate - Adults	1.0-1.5 mmol/L	3.0-4.5 mg/dL
Children	1.3-2.3 mmol/L	4.0-7.0 mg/dL
Platelet count	150-400 x 10^9/L	150,000-400,000/mm^3
pO_2 (arterial)	80-100 mm Hg	80-100 mm Hg
Potassium (serum) - Newborn	3.7-5.9 mmol/L	3.7-5.9 mEq/L
Infant	4.1-5.3 mmol/L	4.1-5.3 mEq/L
Child	3.4-4.7 mmol/L	3.4-4.7 mEq/L
Adult	3.5-5.1 mmol/L	3.5-5.1 mEq/L
Potassium (urine)***	25-125 mmol/d	25-125 mEq/24h
Progesterone (serum) (adult) - Males	0.0-1.3 nmol/L	0.0-0.4 ng/mL
Females (follicular)	0.3-4.8 nmol/L	0.1-1.5 ng/mL
(luteal)	8.0-89.0 nmol/L	2.5-28.0 ng/mL
Prolactin (serum) - Males	1-20 µg/L	1-20 ng/mL
Females	1-25 µg/L	1-25 ng/mL
Prostate specific antigen (PSA)	0-4.0 µg/L	0-4.0 ng/mL
Protein (serum) - Total	60-80 g/L	6.0-8.0 g/dL
Albumin	35-55 g/L	3.5-5.5 g/dL
Protein (urine)	10-150 mg/d	10-150 mg/24h
Prothrombin time (PT)	9-12 sec	9-12 sec
Reticulocytes	25-75 x 10^9/L	25,000-75,000/mm^3
Sedimentation rate (ESR)	0-15 mm/h	0-15 mm/h
Sodium (serum or plasma)	135-145 mmol/L	135-145 mEq/L
Sodium (urine)***	40-220 mmol/d	40-220 mEq/24h
Specific gravity	1.003-1.030	1.003-1.030
Sperm count	20-150 x 10^6/mL	20,000-150,000/mm^3
Testosterone - Males	9.5-30 nmol/L	275-875 ng/dL
Females	0.8-2.6 nmol/L	23-75 ng/dL
Pregnant females	1.3-6.6 nmol/L	38-190 ng/dL
Thrombin time (plasma)	< 17 sec	< 17 sec
Thyroid-stimulating hormone (TSH) (serum) - Adults	0.4-4.8 mIU/L	0.4-4.8 mIU/L
-Term infants: (0-1 day)	1-39 mIU/L	1-39 mIU/L
(1-4 days)	1-17 mIU/L	1-17 mIU/L
(2-20 weeks)	1.7-9.1 mIU/L	1.7-9.1 mIU/L
(21 weeks to 20 years)	0.7-6.4 mIU/L	0.7-6.4 mIU/L
Thyroxine, total (T_4) (serum)**	66-155 nmol/L	5-12 µg/dL
Thyroxine, free (FT_4) (serum)**	13-27 pmol/L	1.0-2.1 ng/dL
Transaminase (serum) -- AST (SGOT)	7-40 IU/L	7-40 mU/mL
ALT (SGPT)	5-35 IU/L	5-35 mU/mL
Triiodothyronine, total (T_3) (serum)	1.1-2.9 nmol/L	70-190 ng/dL
Triiodothyronine, free (FT_3) (serum)	3.5-6.5 pmol/L	2.4-5.0 pg/mL
Triglycerides	0.45-1.71 mmol/L	40-150 mg/dL
Urea (plasma or serum)	2.9-8.2 mmol/L	see Urea nitrogen
Urea nitrogen (BUN) (plasma or serum)	see Urea	8-23 mg/dL
Uric acid (serum) (enzymatic)	120-420 µmol/L	2.0-7.0 mg/dL

*Test values are method dependent **Test values vary with age ***Test values are diet dependent