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QUALIFICATION : BACHELOR of MEDICAL LABORATORY SCIENCES	
QUALIFICATION CODE: 08BMLS	LEVEL: 6
COURSE: CLINICAL CHEMISTRY 2B	COURSE CODE: CLC621S
DATE: NOVEMBER 2023	SESSION: 1
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY: 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 7 pages including this front page

QUESTION 1:**[10 MARKS]**

Write short notes on the pre-analytical and analytical variables of the following laboratory tests and their preferred specimens:

- 1.1 Faecal fat analysis. (5)
- 1.2 Special considerations when measuring serum ammonia. (5)

QUESTION 2:**[10 MARKS]**

Review the following sets of results of patients that are presenting with symptoms associated with hepatic disease. Answer the questions that follow:

Patient A	Patient B
Total Bilirubin: 230µmol/L	Total Bilirubin: 45µmol/L
Direct Bilirubin: 1µmol/L	Direct Bilirubin: 22µmol/L
Total Protein: 63g/L	Total Protein: 55g/L
Albumin: 42g/L	Albumin: 30g/L
ALT: 5U/L	ALT: 800U/L
AST: 88U/L	AST: 390U/L
GGT: 40U/L	GGT: 133U/L
ALP: 80U/L (Ref range:0-249U/L)	ALP: 66U/L (Ref range:40-130U/L)

- 2.1 Indicate which patient is more likely to be suffering from haemolytic disease of the new born. Motivate your answer. (2)
- 2.2 Which patient is more likely to produce pale stools? Motivate your answer. (2)
- 2.3 Indicate whether the following will be increased, normal, decreased or absent for each of patient A and B. (2)
- 2.3.1 Urine urobilinogen
- 2.3.2 Urine bilirubin
- 2.4 Comment on the AST/ALT ratio of patient A. (2)
- 2.5 Assuming that your laboratory performs ionised Ca²⁺ measurements only; would you correct your calcium measurement? Motivate your answer. (2)

QUESTION 3:**[10 MARKS]**

Manual total protein assays were performed on two patient serum specimens and the following absorbance readings were obtained:

Sample	Absorbance reading
Patient A	0.163
Patient B (1/3 dilution)	0.125
Control	0.291
Standard (Concentration = 75g/L)	0.235

- 3.1 Calculate the concentration of total protein for Patient A and B. Round off your final answers to 2 decimal places. (4)
- 3.2 Which patient's result (A or B) is most likely to be observed in a case of: (2)
- 3.2.1 Multiple myeloma
- 3.2.2 Nephrotic syndrome
- 3.3 The package insert of the control states a mean of 72.5g/L and SD=6.25. Showing all calculations, motivate whether or not patient A and B's results can be accepted. (4)

SECTION B: SHORT QUESTIONS**[30 MARKS]****QUESTION 4:****[30 MARKS]**

The following are laboratory results for an adult male patient from the dialysis ward. Review the results and answer the questions that follow.

ANALYTE	CONCENTRATION	REFERENCE RANGE
Serum/Plasma		
Sodium	141	136-146 mmol/L
Potassium	7.7	3.0-5.5 mmol/L
Chloride	107	90-110 mmol/L
CO ₂	22	20-30 mmol/L
Urea	28.9	2.7-8.3 mmol/L
Creatinine	645	90-115 µmol/L
Glucose	19.8	3.5-5.5 mmol/L
Total protein	66	65-80 g/L
Albumin	28	35-50 g/L

ANALYTE	CONCENTRATION	REFERENCE RANGE
Calcium	2.03	2.15-2.45 mmol/L
Osmolality	280	285-295 mmol/kg
Serum Iron	11.2	11-17 μ mol/L
Transferrin	3.5	2.0-3.6 g/L
Cholesterol	6.3	<5.2 mmol/L
Triglyceride (fasting)	3.53	<2.26 mmol/L
HDL	0.9	>1.2 mmol/L
24hr Urine		
Volume	1.3 L	
Creatinine	6	1.0-2.0 mmol/day

Enumerate the following (Show all working):

- 4.1 Anion gap (2)
- 4.2 Corrected calcium (2)
- 4.3 Albumin/globulin ratio (2)
- 4.4 Osmolal gap (2)
- 4.5 Creatinine clearance (3)
- 4.6 TIBC (2)
- 4.7 % transferrin saturation (2)
- 4.8 LDL (3)
- 4.9 Comment on the patient's renal status. (2)
- 4.10 Briefly explain the causes of a low serum sodium in this patient. (5)
- 4.11 Discuss the possible causes of a raised serum potassium. (5)

SECTION C: SHORT AND LONG QUESTIONS

[40 MARKS]

QUESTION 5:

[10 MARKS]

- 5.1 Discuss the tests used for short, medium and long term monitoring of Diabetes. (10)

QUESTION 6: LONG QUESTION

[10 MARKS]

- 6.1 Blood gas samples are very delicate and are to be treated as 'urgent samples'. (10)
Outline the special conditions considered during the pre-analytical and analytical phase for arterial blood gas analysis.

QUESTION 7: LONG QUESTION

[10 MARKS]

- 7.1 Give a detailed description of how the body degrades haemoglobin and the fate of molecules produced during the catabolic process. (10)

QUESTION 8: LONG QUESTION

[10 MARKS]

- 8.1 Using relevant examples describe the five methodologies where enzymes are used as reagents in the clinical chemistry laboratory. (10)

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 ⁹ /L	3000-5800/mm ³
Lymphocytes	1500-3000 x 10 ⁹ /L	1500-3000/mm ³
Monocytes	300-500 x 10 ⁹ /L	300-500/mm ³
Eosinophils	50-250 x 10 ⁹ /L	50-250/mm ³
Basophils	15-50 x 10 ⁹ /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