

Student Number.....

# West Midlands Training Course in Clinical Biochemistry

---

## Course Assessment – Autumn 2009

Short Answer Questions.      Answer all questions.  
Time allowed 1 hour.

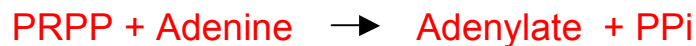
Please write your student number on the paper and NOT your name

1. Name two enzymes involved in the salvage pathway for purines and describe the reactions that they catalyse.      **10 marks**

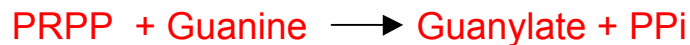
*Enzyme 1:* Adenine Phosphoribosyl Transferase

*Enzyme 2:* Hypoxanthine Guanine Phosphoribosyl Transferase

*Reaction 1*



*Reaction 2*



Student Number.....

2. A laboratory's out of hours service uses 30 different methods, each of which has a 1% probability of failing internal quality control (IQC) criteria during the course of the night. Assuming that the IQC of all methods is independent of any other method, what is the probability that on any night all methods will pass the IQC criteria? **10 marks**

The chance of IQC being in for one analyte is 0.99

The chance of IQC being in for two analytes is  $0.99 \times 0.99$

So for 30 analytes:

$$0.99^{30} = 0.74$$

*Probability* **0.74**

3. List 5 detection systems used in immunoassay **2 marks each**
- i. **Radioactive**
  - ii. **Fluorescence**
  - iii. **Enzyme – colourimetry, fluorimetry, enhanced chemiluminescence, electrochemiluminescence**
  - iv. **Luminescence**
  - v. **Microparticle**
  - vi. **Streptavidin Biotin**
  - vii. **Amplification**
  - viii. **Phosphorescence**

Student Number.....

4. A tumour marker X is used to guide a decision on chemotherapy after the resection of the main tumour mass. The concentration decays exponentially. If the half-life of the tumour marker is less than 85 hours, then this is indicative of tumour clearance and chemotherapy is withheld. If the half life is greater than this, it is an indication that residual disease is present and chemotherapy is indicated. The concentration of X at 50 hours post surgery is 1850 ng/L and at 86 hours it is 1030 ng/L.
- a. Calculate the half life. **8 marks**
- b. Indicate whether you can say with confidence whether chemotherapy needs to be given. **2 marks**

$$I/I_0 = e^{-kt} \quad \text{where} \quad \begin{array}{l} I = \text{concentration at time } t \\ I_0 = \text{concentration at time } 0 \\ K = \text{elimination rate constant} \end{array}$$

$$\ln I/I_0 = -kt$$

$$\ln(1030/1850) = -0.586 = -k \cdot 36$$

$$K = 0.586/36 = 0.0163$$

Substituting in after one half life

$$I/I_0 = 0.5$$

$$\ln 0.5 = -0.0163 \cdot t_{1/2}$$

$$0.693/0.0163 = t_{1/2}$$

$$T_{1/2} = 42.5 \text{ hours}$$

Half Life **42.5 hr**

Requirement for Chemotherapy **Not required**

Student Number.....

5. Calculate the approximate osmolality of an iv solution of dextrose saline containing 5% w/v glucose and 0.9% w/v sodium chloride.

**10 marks**

To determine molarity

5% w/v glucose = 5g in 100 mL

Mol weight of glucose = 180

180g in 1L = 1 mole/L

18g in 100mL = 1 mole/L

5g in 100 mL =  $5/18 * 1 = 0.277$  mole/L

0.9% w/v NaCl = 0.9g in 100 mL

Mol weight NaCl = 58

58g in 1L = 1 mole/L

5.8g in 100 mL = 1 mole/L

0.9g in 100 mL =  $0.9/5.8 * 1 = 0.155$  mole/L

To determine osmolality

1 particle glucose & 2 NaCl =  $(0.155*2) + 0.277 = 0.587$  mole/kg

Osmolality 587 mmol/kg

Student Number.....

6. A 35 year old Indo-Asian woman complains of tiredness and is found to be anaemic. She is a vegan and has a regular menstrual cycle. Relevant laboratory investigations are listed below:

Haemoglobin	9.3 g/L	(11.5 -16.0)
MCV (mean red cell volume)	82.0	(80.0-100)
Haemoglobin electrophoresis:	No abnormality	
B12	57 pg/mL	(187 - 1059)
Folate	1.5 ng/mL	(2.5 -11.9)
Iron	5 $\mu$ mol/L	(10 – 30)
UIBC	90 $\mu$ mol/L	(50 - 70)
Ferritin	3 ng/mL	(15 -300)

UIBC = Unsaturated Iron binding Capacity

- a. Calculate total iron-binding capacity (TIBC) **2 marks**

$$\text{TIBC} = \text{UIBC} + \text{Iron} = 90 + 5$$

$$\text{TIBC} = 95 \mu\text{mol/L}$$

- b. What is the % transferrin saturation? **2 marks**

$$\text{Iron/TIBC} * 100 = 5/95 * 100 = 5.3\%$$

% Transferrin Saturation **5.3%**

- c. What three nutritional deficiencies may underlie her anaemia? **3 marks**

i. **Iron deficiency**

ii. **Folate deficiency**

iii. **B12 deficiency**

- d. List one possible single diagnosis to explain underlying causes **1 mark**

Diagnosis **Dietary Deficiency or Malabsorption**

**(Allow pernicious anaemia because it can cause iron deficiency anaemia)**

- e. Give two further investigations that may be required? **2 marks**

Student Number.....

- i. Dietary Assessment
- ii. Test for diagnosis of Malabsorption
  - a. Coeliac screen TTG, endomysial Ab, gliadin Ab
- iii. Allow parietal cell antibodies and intrinsic factor antibodies. (Schillings test no longer done)

7. List three possible causes of the following thyroid function test results obtained on a 35 year old woman:

FT4 = 33 pmol/L

TSH = 5.0 mU/L

**2 marks each**

- i. On Thyroxine, compliance issue or recently started
- ii. Interference in thyroid assays
- iii. Thyroid resistance
- iv. TSHoma
- v. Non thyroidal illness

Give four potential further actions/tests that you could perform to further elucidate the cause **1 mark each**

- i. Repeat test
- ii. FT3
- iii. Discuss compliance with GP
- iv. Send sample to another lab with different method
- v. Heterophilic antibody blocking tubes
- vi. TRH test
- vii. Alpha subunit
- viii. SHBG
- ix. Other pituitary hormones
- x. MRI pituitary
- xi. Family history
- xii. Gene analysis

Student Number.....

8. A group of 192 blood donors are tested for a polymorphism in the rhuvarbin gene. 121 are found to have the RR genotype and 12 the rr genotype. Calculate:

- a. The expected allele frequencies for the R & r alleles  
3 marks

Observed genotypes:

RR	Rr	rr	Total
121	59	12	192

Calculate allele frequencies:

$$R \text{ alleles} = (2 \times 121) + 59 = 301 / 384 = 0.784$$

$$r \text{ alleles} = (2 \times 12) + 59 = 83 / 384 = 0.216$$

- b. The expected number of blood donors with each of the two possible phenotypes if "R" is completely dominant over "r"  
3 marks

Expected genotypes

$$RR = (0.784)^2 = 0.6147 \times 192 = 118$$

$$Rr = 2 \times 0.784 \times 0.216 = 0.3387 \times 192 = 65$$

$$rr = (0.216)^2 = 0.0467 \times 192 = 9$$

$$\text{Phenotype 1} = RR + Rr = 118 + 65 = 183$$

$$\text{Phenotype 2} = rr = 9$$

Student Number.....

Based on these data, comment on the conformity to the Hardy-Weinberg equilibrium. 2 marks

Observed similar to expected. Likely to conform to H-W equilibrium

If a patient population with rhuarbitis shows that 22% are rr homozygotes, comment on these findings compared with those in the population above. 2 marks

22% in patients with rhuarbitis much higher than expected 4.7% in general population (blood donors) with rr genotype. Therefore, rhuarbin is associated with increased risk of rhuarbitis.

Student Number.....

9. Calculate the positive predictive value for IgA-tissue transglutaminase antibody in a population with a prevalence of coeliac disease of 10% (assuming test sensitivity of 90% and specificity of 95%). **10 marks**

Assuming a population of 1 million

	Diseased	Non-Diseased	Total
Positive Test	90000 (TP)	45000(FP)	135000
Negative Test	10000 (FN)	855000(TN)	865000
	100000	900000	1000000

Where TP = true positives, FP = false positives, TN = true negatives & FN = false negatives

Predictive value of a positive result =  $TP/(TP + FP) * 100 = 90000/135000 = 66.7\%$

Positive Predictive Value **66.7%**

Student Number.....

10. Please indicate whether the following statements are **TRUE** or **FALSE** **2 marks each**

- a. A serum cortisol result of 25 nmol/L post overnight dexamethasone suppression test makes Cushing's syndrome unlikely.
- b. A serum cortisol result of 300 nmol/L on a sample collected 30 minutes post 250 µg Synacthen i.m excludes adrenal insufficiency.
- c. The best way to differentiate between primary and secondary adrenal failure is to measure 24 hour urinary free cortisol.
- d. Deficiency in 21 hydroxylase activity in the adrenal zona fasciculata results in the accumulation of 11 deoxycortisol.
- e. The hypertension associated with 11 $\beta$  hydroxylase deficiency is mainly due to the accumulation of 11-deoxycorticosterone

- a. **TRUE**
- b. **FALSE**
- c. **FALSE**
- d. **FALSE**
- e. **TRUE**

Student Number.....