Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2018					

MLS 245 Medical Biochemistry	DURATION	
	Reading Time:	10 minutes
	Writing Time:	120 minutes

INSTRUCTIONS TO CANDIDATES

The examination has two sections:

Section A: Suggested Time: 60 min Multiple Choice Questions: 25 questions

Total: 50 marks (2 mark each)

Section B: Suggested Time: 60 min Short Answer Questions: six questions

Total: 45 marks

Section A must be answered on the multiple-choice answer sheet provided and must be handed in with your answer booklet.
Section B must be answered in the answer booklet.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 16 Page Book 1 x Scrap Paper College Multiple Choice Answer Sheet

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Section A

Section B
Case Study Based Questions
Total Number of Marks for this section: 45 Marks

This section should be answered in the Answer Booklet provided.

Marks for each question are indicated.
Suggested Time allocation for Section B: **60 minutes**

Question 1

i. What phenomenon in genetic coding does “wobble” refer to? Give a brief description.

ii. Explain the benefit of using thymine in DNA instead of uracil.
Thymine has greater resistance to photochemical mutation, making the genetic message more stable.

(3+3 = 6 Marks)

Question 2

You want to design an experiment to determine the order of genes in the *lac* operon. You selectively block RNA polymerase before it transcribes each gene in the operon and then measure the protein levels of each of the genes transcribed by the *lac* operon. The results are in the table below

Gene Blocked	Permease Produced	Beta-galactosidase Produced	Transacetylase Produced
Gene 1	No	No	No
Gene 2	No	Yes	No
Gene 3	Yes	Yes	No

i. What is the correct sequence of proteins found in the lac operon?

ii. What is the benefit of the repressor being constitutively (constantly) produced?

iii. In the *lac* operon, the repressor protein exerts a negative effect on the expression of the structural genes in the absence of the inducer molecule. In the case of the *lac* operon, what is the inducer molecule?

iv. Why does *E.coli* have polycistronic messages?

v. What will happen when lactose is present as the sole energy source?

(2+1+1+1+1=6 Marks)

Question 3

In a biochemistry experiment, *Student A* investigates the enzyme kinetic reaction of lactate dehydrogenase (LDH). He extracts the LDH from chicken breast fillet he bought at supermarket, and uses lactate as the substrate for this experiment. After preparing various concentration of substrate with the same amount of enzyme, he determines the initial rate of the reactions as displayed in following table:

(*Note: LDH is a group of enzymes that catalyze the reaction which interconvert lactate and pyruvate, and found abundance in animal tissues*.)

Substrate concentration (mM)	Initial velocity (V_0) μM sec^{-1}
2	16.2
4	27.0
6	32.0
8	35.0
10	36.0

Student A is told that the LDH he extracted from chicken breast may contain compound(s) that interfere with the enzyme. He repeats the experiment using the same amount of LDH, but with purified laboratory graded enzyme. The result he recorded is displayed as follow:

Substrate concentration (mM)	Initial velocity (V_0) μM sec^{-1}
2	23.2
4	38.0
6	46.0
8	50.0
10	52.0

Answer the following questions:

i. What is the V_{max} and K_m for each of the enzymatic reaction?
ii. How would you explain the two different sets of results, considering that *Student A* has used the exact same amount of LDH enzyme?
iii. If this reaction is to occur within a living chicken (Note: chicken has normal body temperature of ~41°C), how would this reaction rate different?

(6+3+3 = 12 Marks)

Question 4

Ribosomes were isolated from bacteria grown in a “heavy” medium (^{13}C and ^{15}N) and from bacteria grown in a “light” medium (^{12}C and ^{14}N). These 60S ribosomes were added to an *in vitro* system actively engaged in protein synthesis. An aliquot removed several hours later was analysed by density-gradient centrifugation.

How many bands of 70S ribosomes would you expect to see in the density gradient?

(4 Marks)

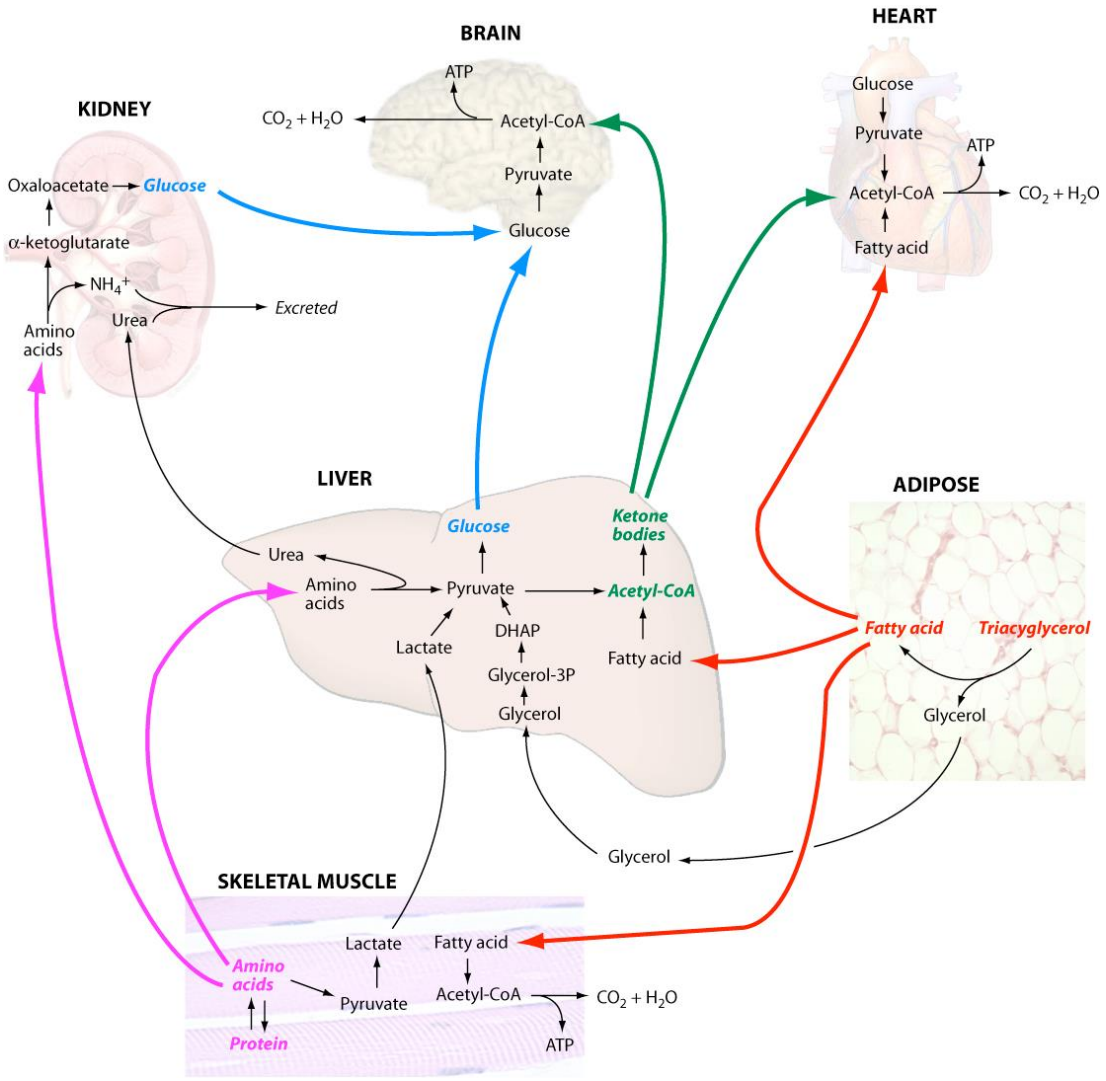
Question 5

What are the key enzymatic differences between liver, kidney, muscle, and brain that account for their differing utilization of metabolic fuels?

(5 Marks)

Question 6

Metabolite flux between major tissues and organs in the human body under starvation conditions is illustrated in the figure below:



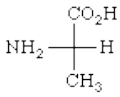
Once glycogen stores are depleted (first 24 hours), there are four major alterations in metabolic flux that permit humans to survive long periods of time without food. Please give a summary of these **four** alterations.

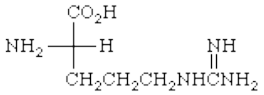
(12 Marks)

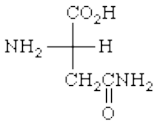
Appendix

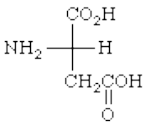
Amino Acid Structures

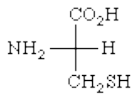
The following amino acid structures are listed in alphabetical order. Ionizable groups are shown in their neutral form - this implies absolutely nothing about the predominant form at any particular pH.

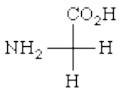

Alanine

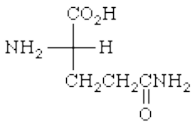

Arginine

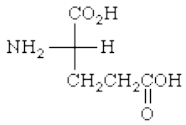

Asparagine

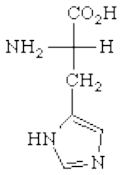

Aspartic Acid

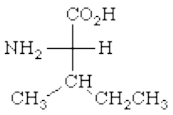

Cysteine

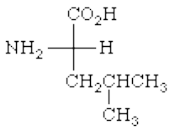

Glycine

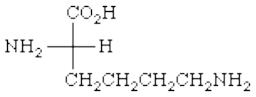

Glutamine

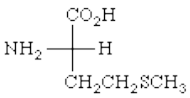

Glutamic Acid

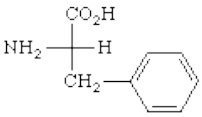

Histidine

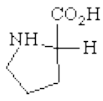

Isoleucine

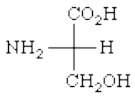

Leucine

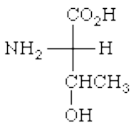

Lysine

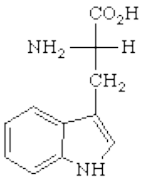

Methionine

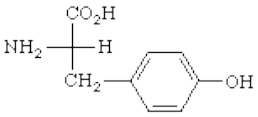

Phenylalanine

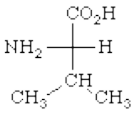

Proline


Serine

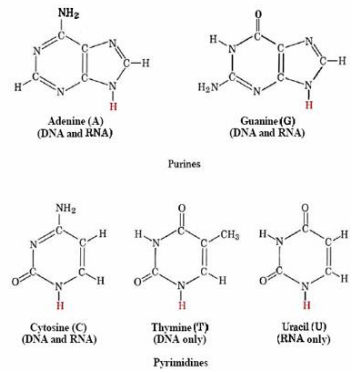

Threonine


Tryptophan


Tyrosine


Valine

Nucleic acids structures



The following table gives the pKa values for the α-carboxylic acid group, the α-amino group, and any ionizable side chains.

Amino Acid	α-carboxylic acid	α-amino	Side chain
Alanine	2.35	9.87	
Arginine	2.01	9.04	12.48
Asparagine	2.02	8.80	
Aspartic Acid	2.10	9.82	3.86
Cysteine	2.05	10.25	8.00
Glutamic Acid	2.10	9.47	4.07
Glutamine	2.17	9.13	
Glycine	2.35	9.78	
Histidine	1.77	9.18	6.10
Isoleucine	2.32	9.76	
Leucine	2.33	9.74	
Lysine	2.18	8.95	10.53
Methionine	2.28	9.21	
Phenylalanine	2.58	9.24	
Proline	2.00	10.60	
Serine	2.21	9.15	
Threonine	2.09	9.10	
Tryptophan	2.38	9.39	
Tyrosine	2.20	9.11	10.07
Valine	2.29	9.72	

Equations:

Michaelis-Menten equation

$$V_0 = \frac{V_{MAX}[S]}{[S] + K_M}$$

Linewaver-Burk plot

Plot of 1/V versus 1/[S] (→ straight plot)

intercept $1/V_{MAX}$, $-1/K_M$

slope K_M/V_{MAX}

$$\frac{1}{V} = \frac{1}{V_{MAX}} + \frac{K_M}{V_{MAX}[S]}$$