THE UNIVERSITY OF BRITISH COLUMBIA
School of Kinesiology: KIN 275 – Exercise Physiology I

Practice Exam

Total: /70 marks

Section A – Multiple Choice & True or False (Total 25 marks)
Multiple Choice Questions (1 mark each) Circle the **ONE BEST** answer

1. During whole body endurance exercise, diastolic blood pressure:
   a. Remains close to resting values
   b. Increases in proportion to exercise intensity
   c. Decreases in proportion to exercise intensity
   d. Is bi-phasic; it decreases then increases

2. Which of the following does not contribute to increasing dry heat loss during exercise?
   a. *an increase in core temperature from 37°C to 38.5°C*
   b. *peripheral vasodilation*
   c. *an increase in self generated air-velocity*
   d. *low ambient air temperature*
   e. *a high water vapour pressure gradient*

3. During maximal exercise, carbon dioxide is carried in the blood primarily by:
   a. *Diluted directly into plasma*
   b. *Combined with Hb in the red blood cell*
   c. *In the form of bicarbonate ion (HCO_3^-)*
   d. *None of the above*

4. A typical partial pressure of oxygen in the alveoli in an individual breathing at sea-level is:
   a. *159 mmHg*
   b. *40 mmHg*
   c. *104 mmHg*
   d. *60 mmHg*

5. The technique(s) used to endurance train the respiratory muscles is called:
   a. *Voluntary isocapnic hyperpnea*
   b. *Flow resistive loading*
   c. *Pressure threshold loading*
   d. *Endurance of the respiratory muscles can not be improved with respiratory muscle training*
   e. *a, b, and c*

6. Which of these is not a proposed benefit of taking amphetamines?
   a. *weight loss*
   b. *delayed fatigue*
   c. *enhancement of every aspect of performance*
   b. *decreased performance anxiety*

7. _____ glycemic index foods are best before exercise, while _____ glycemic index foods are best immediately after exercise.
   a. *Low, high*
   b. *High, low*
   c. *Moderate, high*
   d. *Moderate, low*

8. Why is water vapor pressure lower at altitude?

a. Cold air cannot hold very much water.
b. Rain doesn't fall at high elevations.
c. Mountains are only found in dry regions.
d. Humidity, not water vapor pressure, is the low variable.

9, The effects of anabolic steroids most closely reflect the natural effects of:

a. estrogen
b. testosterone
c. EPO
b. IGF-1

10. The major factor that drives the acute altitude-associated decrease in performance is:

a. inadequate pulmonary ventilation
b. inadequate pulmonary diffusion
c. inadequate alveolar PO_2
d. inadequate muscle oxidative enzymes

11. Which form of body composition assessment relies on tissue conductivity?

a. DEXA
b. hydrostatic weighing
c. bioelectrical impedance
b. air plethysmography

12. It appears that increases in muscular strength cannot be achieved without:

a. structural changes in muscle tissue
b. neural adaptations
c. both neural adaptations and structural changes in muscle
d. changes in muscle fiber type

13. Neural mechanisms that may help explain some of the strength gains from resistance training include all of the following except:

a. increased synchronization of motor unit activation
b. increased autogenic inhibition
c. rate coding
b. *decreased coactivation of agonists and antagonists*

14. Studies in which cats trained to lift very heavy weights over months of resistance training demonstrated that muscle size can change through muscle fiber:

a. atrophy
b. hypertrophy
c. hyperplasia
d. hypoplasia

15. Which of the following statements explaining the increase in SV after aerobic training is correct?

a. preload, distensibility, and afterload increase
b. preload, contractility, and afterload decrease
c. preload and contractility increase, afterload decreases
b. preload decreases, contractility and afterload increase

16. In comparison to a sedentary individual, a well-trained athlete will usually have all of the following characteristics except:

a. *higher cardiac reserve*
b. *a higher resting cardiac-output*
c. *a higher stroke volume*
d. *hyptertorphy of the heart*
e. *resting bradycardia*

17. After aerobic training, more existing capillaries are now open in exercising muscle vasculature. This phenomenon is called:

a. *capillary-to-fiber attraction*
b. *capillary recruitment*
c. *angiogenesis*
d. *capillarization*

18. The complete list of 8 essential amino acids for <u>adults</u> is:

a. *Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine*
b. *Threonine, Tryptophan, Valine, Glycine, Cysteine, Isoleucine, Leucine, Lysine*
c. *Methionine, Phenylalanine, Threonine, Tryptophan, Valine, Glutamic acid, Isoleucine*
d. *Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine, Arginine*

19. The female triad is characterized by all of the following conditions, except:

a. *disordered eating*
b. *menstrual irregularities*
c. *high levels of fat-free mass*
d. *bone mineral density problems*

20. When motor units contract more synchronously,

a. *muscles cannot sustain steady forces anymore*
b. *muscles increase the rate of force development*
c. *the ability to generate force is impeded*
d. *a single motor neuron now innervates several motor units*

True or False: Circle the correct answer (1 mark each)

1. Infusing EPO is safer than blood transfusion when blood doping. *True or False*

2. When muscles atrophy due to immobilization, the cross-sectional area decreases and several studies have shown this effect to be greater in type I fibers. *True or False*

3. Hypocapnia is a condition marked by low levels of CO_2 in the blood due to breathing excessively. *True or False*

4. A condition in which the arterial oxygen saturation falls below 95% during acute aerobic exercise at sea-level in a healthy individual is referred to as hypoxaemia *True or False*

5. The majority of daily water intake actually comes from water content in food. *True or False*

Section B – Short Answer Questions: only answer **5 out 6** questions (25 marks total)

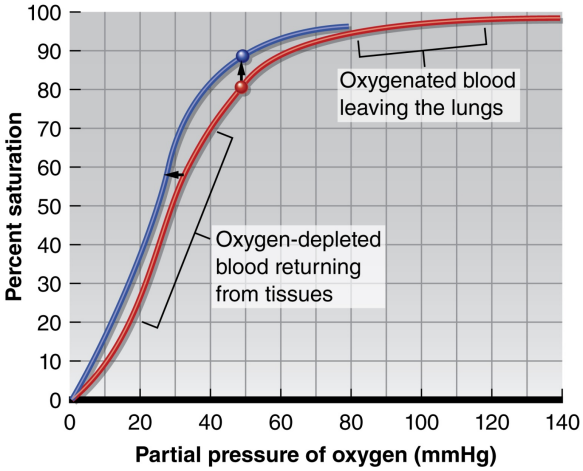
1) A 20 yr-old, 65 kg female athlete is performing and incremental exercise and the following values are recorded at the maximal stage of exercise; stroke volume = 150 mL/beat; (a-v)O_2 difference = 15 mL/100 mL blood. What is this athlete's relative VO_2 max? Show your work. (5 marks)

HR Max = 220 – Age
= 220 – 20
= 200 bpm

VO_2 = Q * (a-v)O_2 diff
= (SV * HR) * (a-v)O_2 diff
= (150ml/beat * 200 bpm) * 15ml/100 mL blood
= 4500 ml/min
= 4.5 L/min

Relative VO2 = VO2 / weight
= 4.5L/=.min^{-1} / 65 kg
= 69 ml/kg.min^{-1}

2) Graph how the oxyhemoglobin dissociation curve is affected by ascending to altitude. Describe: i) what the implications of such a response at the alveolar and skeletal muscle level, and ii) which orally administrated drug would contribute to reversing this effect. (5 marks)



Implications: Increased loading of O_2 to hemoglobin at the level of the lung
Decrease unloading of O_2 at the level of the tissue

Drugs: Acetazolamide (Diamox)

3) The cardiovascular system tightly regulates blood flow to satisfy the immediate needs of active tissue. Describe how blood flow is *redistributed* during prolonged endurance exercise compared to a resting state in relative and absolute terms. (5 marks)

Blood flow (Cardiac Output) increases substantially during exercise, from resting values of ~5 L/min to maximal exercise values of ~20 L/min to up to 40 L/min (in trained athletes)

The observed increase in blood flow precisely matches increases in O2 demand.

At rest, skeletal muscle receives ~20% of total cardiac output, during maximal exercise, the total fraction of cardiac output increases to ~80%. As such, blood flow to the skeletal muscle increases in both relative and absolute terms.

* Give at least one example of blood flow redistribution in other tissues:

Blood flow the kidneys, gastrointestinal tract, brain and liver decrease in both relative and absolute terms.

Blood flow to the heart increases in absolute terms but is maintained relative terms

Blood flow to the skin is low at rest, and increases in absolute terms during exercise. However, this response is highly variable, depending on the body's thermal status.

4. DOMS commonly affects athletes who perform exhaustive or very high intensity exercise.
    a. List 2 major contributors to the loss of strength seen in the first 24hrs of DOMS and list the best way/method to minimize DOMS. (3 marks)

    b. Outline the 3 proposed mechanisms that are thought to cause DOMS (2 marks)

A - Major contributors to loss of strength in DOMS:
1. Physical disruption of muscle (see previous slides)
2. Failure in excitation-contraction coupling (appears to be most important)
3. Loss of contractile protein

3 "best" methods of reducing DOMS:
Reduce the eccentric component of muscle action during early training
Start training at a low intensity and gradually increase it
Begin with a high-intensity, exhaustive bout of eccentric-action exercise, which will cause much soreness initially but will decrease future pain

B – 3 mechanisms:
1. Structural Damage
2. Ca2+ leaking out of the SR
3. Inflammation & Swelling

5. Trained athletes often exhibit a lower resting heart rate than untrained individuals. In point form, explain why endurance training results in a lower resting heart rate (5 marks).

Cardiac Output is the same at rest between trained and untrained individuals

Trained individuals have an increased SV, due to an increased preload, decreased afterload (small) and an increased contractility (small)

This results in an increased parasympathetic (vagal) tone, which decreases HR for a given cardiac output

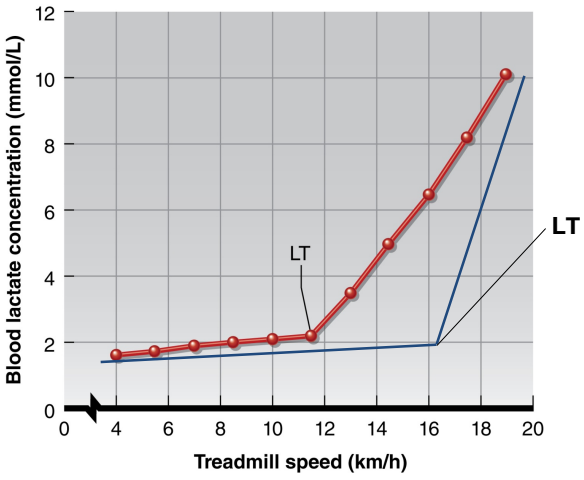
6. Define what is the lactate threshold? Describe a method by which it can be assessed, and what is its relationship to sport performance? Use a graph to illustrate how lactate threshold can change as a function of aerobic training. (5 marks)

Lactate Threshold: point at which blood lactate accumulation increases markedly

Lactate production by the muscle decreases as aerobic capacity increases. The capacity of the liver to metabolize lactate is relatively fixed.

It can easily be assessed by taking blood serial samples during incremental exercise and monitoring lactate concentration.

An athlete with a higher LT will be able to exercise at a higher fraction of VO2max for a longer period of time without exhibiting substantial increases in lactate concentration



Blue = Fit
Red = Less Fit

Section C - Long Answer Questions. Only answer **2 out 4** questions. You may explain clearly in **point form** (20 marks).

1) Ascending to altitudes above 5500 meters imposes major challenges on the human body that adversely affect health and performance. (10 marks)

i. Describe the environmental conditions at altitude and how they affect the respiratory and cardiovascular systems.
ii. Describe 3 major complications that can occur following acute altitude exposure.
iii. Describe 2 methods that are commonly used to mitigate the detrimental effects of altitude on performance and health

i.
Conditions: Low atmospheric pressure (and by association, low PO2), low ambient temperature and dry air (low relative humidity)

Respiratory:
- Increased ventilation for a given vo2
- Decreased PaCO2
- Increased blood pH
- Shift in the oxyhemoglobin dissociation curve
- Kidneys excrete more bicarbonate

Cardiovascular
- Decreased Plasma Volume
- Decreased SV
- Increased HR
- Increased cardiac output for a given VO2
- Long term, hypoxia induced increase in EPO, which increases red blood cell count

ii.
Acute mountain sickness
High Altitude Pulmonary Edema
High Altitude Cerebral Edema

iii.
Supplemental O2
Acetazolamide (Diamox)
Sildenafyl (Viagra)

2) Exercise 'disrupts' the body's internal environment. In order to maintain homeostasis, the body possesses regulatory systems are designed to monitor changes within the body, mostly via a *negative feedback mechanism*. Use an example discussed in class that illustrates this phenomenon. In your answer, be sure to include variables monitored, sensors, effectors, integration centers, and the overall event. You may use a graph to help illustrate your answer. (10 marks)

Several potential options (see course slides if they elect to describe an obscure mechanism)

Thermoregulation

- Variable(s) monitored: Body Temperature
- Sensors: Central & Peripheral Thermoreceptors
- Integration Center: Hypothalamus
- Effectors: Cold (skeletal muscle, vasculature), Heat (sweat glands, vasculature)
- Overall event: Increase or Decrease in body temperature

ADH

- Variable(s) monitored: Plasma Volume
- Sensors: Hypothalamus
- Integration Center: Hypothalamus/Pituitary
- Effectors: Pituitary
- Overall event: Secretion of ADH, which affects the kidneys

3) Blood doping is a technique employed by endurance athletes in order to artificially increase aerobic capacity that can be achieved by: i) infusion of erythropoietin (EPO), and ii) by blood transfusion. Based on what you've learned during this course, describe these 2 methods of blood doping and the physiological mechanism(s) by which they contribute to increasing aerobic capacity. (10 marks)

i) Erythropoietin is the naturally occurring hormone that stimulates red blood cell production. It increases the number of red blood cells, and therefore the blood's oxygen-carrying capacity.

ii) Blood doping refers to an artificial increase in the total volume of red blood cells. It has been proposed to improve endurance performance by increasing the blood's oxygen-carrying capacity.

Studies have shown major increases in maximal oxygen uptake, time to exhaustion, and actual performance in endurance events as a result of blood doping and EPO administration.

The mechanism by which aerobic capacity is increased is via an increase in hematocrit and a subsequent plasma volume expansion. Overall, the increase hemoglobin mass results in an increased capacity to provide the active tissues with oxygen.

4) For <u>one</u> of the athletes described in the table below, design the initial phase of a resistance training

program that is tailored to their needs by focusing on improving either strength, power, or endurance. Outline the basic details of their program (*Volume*, *Loading*, *Velocity* and *Frequency*). Assuming that these athletes are considered 'novices' in the context of resistance training, describe <u>two</u> key principles that they would need to follow in order adjust their training as they become more proficient. (10 marks)

Component	Athlete A	Athlete B	Athlete C
Strength[a]	100 kg	200 kg	200 kg
Power[b]	100 kg lifted 0.6 m in 0.5 s = 120 kg · m/s = 1,177 J/s or 1,177 W	200 kg lifted 0.6 m in 2.0 s = 60 kg · m/s = 588 J/s or 588 W	200 kg lifted 0.6 m in 1.0 s = 120 kg · m/s = 1,177 J/s or 1,177 W
Muscular endurance[c]	10 repetitions with 75 kg	10 repetitions with 150 kg	5 repetitions with 150 kg

Athlete A = Poor in Strength
Athlete B = Poor in Power
Athlete C = Poor in Endurance

Programs should closely resemble the contents of the following table in terms of Volume, Loading, Velocity & Frequency.

Primary goal of resistance training program	Training level	Loading	Volume	Velocity	Frequency (times per week)
Strength development	Novice	60-70% 1RM	1-3 sets, 8-12 reps	Slow, moderate	2-3
	Intermediate	70-80% 1RM	Multiple sets, 6-12 reps	Moderate	3-4
	Advanced	80-100% 1RM	Multiple sets, 1-12 reps	Unintentionally slow to fast	4-6
Development of muscle power	Novice	0-60% 1RM—lower body; 30-60% 1RM—upper body	1-3 sets, 3-6 reps	Moderate	2-3
	Intermediate	0-60% 1RM—lower body; 30-60% 1RM—upper body	1-3 sets, 3-6 reps	Fast	3-4
	Advanced	85-100% 1RM	3-6 sets, 1-6 reps, various strategies	Fast	4-5
Increased local muscular endurance	Novice	Light	1-3 sets, 10-15 reps	Slow—moderate reps Moderate—high reps	2-3
	Intermediate	Light	1-3 sets, 10-15 reps	Slow—moderate reps Moderate—high reps	3-4
	Advanced	30-80% 1RM	Various strategies, 10-25 reps or more	Slow—moderate reps Moderate—high reps	4-6

2 out of the following principles:

- Principle of Individuality
- Principle of Specificity
- Principle of Reversebility
- Principle of Progressive Overload
- Principle of Variation

Section D - *BONUS* Question. (3 marks).

At sea-level, a healthy individual at rest will have an arterial oxygen tension (PaO_2) of ~105 mmHg, oxygen saturation (SaO_2%) of ~98%, and an arterial oxygen content (CaO_2) of ~20 ml O_2/100 ml of blood. If this same individual is placed in a *hyperbaric* chamber, which increases atmospheric pressure to *2 atmospheres*, what will happen to PaO_2, SaO_2%, and CaO_2?

760 mmHg * 2 = 1520 mmHg

PaO_2 = 210 mmHg
SaO_2% = 100%
CaO_2 = 20.06 ml/100ml of blood