EXS202: HUMAN PHYSIOLOGY 1: LECTURE NOTES (SAMPLE)

WEEK 1: ENERGY TRANSFER AND BIOENERGETICS

List the 4 forms energy is stored in humans.

- Chemical
- mechanical
- thermal
- Electrical

What is the relationship between chemical, mechanical, thermal and electrical energy in the human body?
Chemical energy is turned into electrical energy to send a signal down a neuron before returning to chemical form. This then results in mechanical energy as the neuron acts on a muscle which can have a thermal component.

What are the 2 types of energy?

- Kinetic energy
- potential energy

How is most energy stored in the human body?
Most energy in the human body is stored as chemical energy.

All human movement is based on energy _____.
All human movement is based on energy shift.

What is work and how does it related to energy?
Work is producing a given force over a given distance. Without energy no work can be done resulting in no muscle contraction.

Where does energy come from?
Energy cannot be created. Every new form of energy is a transfer from another. E.g. Water moving through a turbine creates electrical energy.

Human energy comes from _____.
Human energy comes from food and is measured as Calories (kcal).

How many calories does one gram of carbohydrate provide?
One gram of carbohydrate provides 4 kcal.

How many calories does one gram of protein provide?
One gram of protein provides 4 kcal.

How many calories does one gram of fat provide?
One gram of fat provides 9 kcal.

How many calories does one gram of alcohol provide?
One gram of alcohol provides 7 kcal.

How efficient are humans at transferring energy from one form to another?
Humans are 17-22% efficient (25% max) at transferring energy from one form to another. The rest is lost through heat.

What is random energy?
Random energy is energy that does not contribute to movement. Instead it becomes heat.

What is normal body temperature?
Normal body temperature is 37°C.

Body temperature should not go beyond _____°C.
Body temperature should not go beyond 42°C.

What occurs if body temperature goes beyond 42°C?
If body temperature goes beyond 42°C, protein starts to break down including protein in the brain, you can go into coma, organ failure and die.

What is PCr?
PCr is phosphocreatine. Phosphocreatine is an organic compound of creatine and phosphoric acid. PCr is found in the muscles of vertebrates where its hydrolysis releases energy for muscular contraction.

What is ATP?
ATP is adenosine triphosphate. ATP is a nucleotide derived from adenosine that occurs in muscle tissue. ATP is the major source of energy for cellular reactions. ATP is our preferred energy storage molecule.

What is creatine?
Creatine is an amino acid that does not occur in proteins but is found in the muscle tissue of vertebrates both in the free form and as phosphocreatine. Creatine supplies energy for muscle contraction.

What is enthalpy?
Enthalpy accounts for the loss of energy in a spontaneous reaction. Energy is lost into the atmosphere (in an open environment), therefore atmospheric conditions affect but this is not an issue in the body. Enthalpy is the change in energy during a reaction. Enthalpy is denoted by H.

How is change in enthalpy denoted?
ΔH denotes change in enthalpy.

What is Gib's Free Energy?
Gib's Free Energy is usable energy as a result of a reaction. Gib's Free Energy is denoted by G. G is energy that can make muscles contract, systems run and support life.

What does ΔH= ΔG + TΔS mean?
The above equation represents a change in energy in the system during a reaction is equal to a change in usable energy plus temperature times entropy. TΔS means the hotter the environment the more random energy becomes. Consequently if we cool the temperature, energy becomes less random.

What would a negative ΔG denote?
Negative ΔG denotes an exothermic reaction.

What is equilibrium?
Equilibrium refers to a system that is in a standstill. Reactions will proceed until equilibrium is reached. More and more entropy will occur with each reaction until equilibrium is reached.

How is hydrolysis of ATP represented in denotations?
$ATP + H_20 \leftrightarrow ADP + P_i + H^+ + Energy + S$

Where;
ATP is adenosine triphosphate
ADP is adenosine triphosphate
H^+ is a hydrogen ion
S is entropy (heat) (useless energy)
H_20 is water
P_i is phosphate
Energy is Gibs Free Energy (usable energy)

What are the two energy systems within the anaerobic energy system?
- PCr
- glycolysis

What is the energy system within the aerobic energy system?
Oxidative phosphoralisation

What is the PCr energy system?
The phosphocreatine energy system is an anaerobic energy system and the fastest acting energy system, as it only requires one chemical reaction to produce ATP. The PCr energy system peaks ATP supply between 5-15 seconds during supramaximal exercise.

Where is ATP used in the body?
ATP is vital for all processes in the body including muscle contraction. ATP does not cause muscle contraction but it is essential for the cross-bridge between actin and myosin. ATP binds to myosin and phosphorylates. This puts the myosin into a ready state to attach to actin. Once myosin and actin are bound ATP drops off, myosin relaxes while the muscle contracts. Then ATP binds onto myosin, releases it from actin and the process repeats. (Sliding Filament theory).

ENERGY AND BIOENERGETICS: ENERGY SYSTEM QUIZ

In terms of energy delivery, please list the following from fastest to slowest.
Fastest: ATP-Pool
Second fastest: PCr system
Third fastest: Glycolysis
Fourth fastest: Oxidative metabolism

What does the hydrolysis of ATP do at the muscle?
At the muscle, the hydrolysis of ATP places the myosin head into a high energy state.

What does ATP become during the hydrolysis of ATP?
During the hydrolysis of ATP, ATP becomes ADP.

At best case, the human body is _____% efficient.
At best case, the human body is 25% efficient.

Of the 6 forms of energy, which form of energy could you use to define the food we eat?
Chemical energy could be used to define the food we eat.

Both the PCr and Adenylate Kinase systems are extremely fast at replenishing ATP. What else to the two systems have in common?
Both are water soluble and occur in the cytosol of the cell.

How does an enzyme help the rate of a reaction?
An enzyme lowers the energy of activation required for the reaction.

What is the Gib's free energy (ΔG) for the hydrolysis of ATP?
-7.3 kcal/mol.

Please indicate the energy content of 1 gram of carbohydrate.
4 kcals.

During the transfer of energy, some will be useful while some will contribute to the randomness of a system. What is the latter termed?
Entropy is the randomness of energy. (Second law of thermodynamics)

A reaction in which the products aid an additional reaction is called _____.
A reaction in which the products aid an additional reaction is called coupled.

WEEK 11: ENDURANCE TRAINING AT ALTITUDE

At what altitude are international standard events held regarding altitude?
International standard events are limited to altitudes of less than 3500m except for football in Bolivia which is at 3600m. However endurance events such as cycling races that are held at higher altitude.

Does altitude affect performance in events of short distance (e.g. 400m race)?
Performance in short distance events is not really influenced by moderate altitude. Performance may not change or slightly improve due to reduced drag.

What is the relationship between air density and VO2max?
Events beyond 1-2 minutes can show influences of altitude. Air density is reduced at altitude and therefore there is less drag at high velocity but there is also less O_2 available which reduces aerobic metabolism capacity.

What is the classic approach to altitude training?
Classically, altitude raining involves living and training at altitudes between 1800- 3000m for 2- 4 weeks in order to prepare for sea level or altitude competition. While this trains the body to be more efficient at O_2 extraction, the intensity of the training suffers.

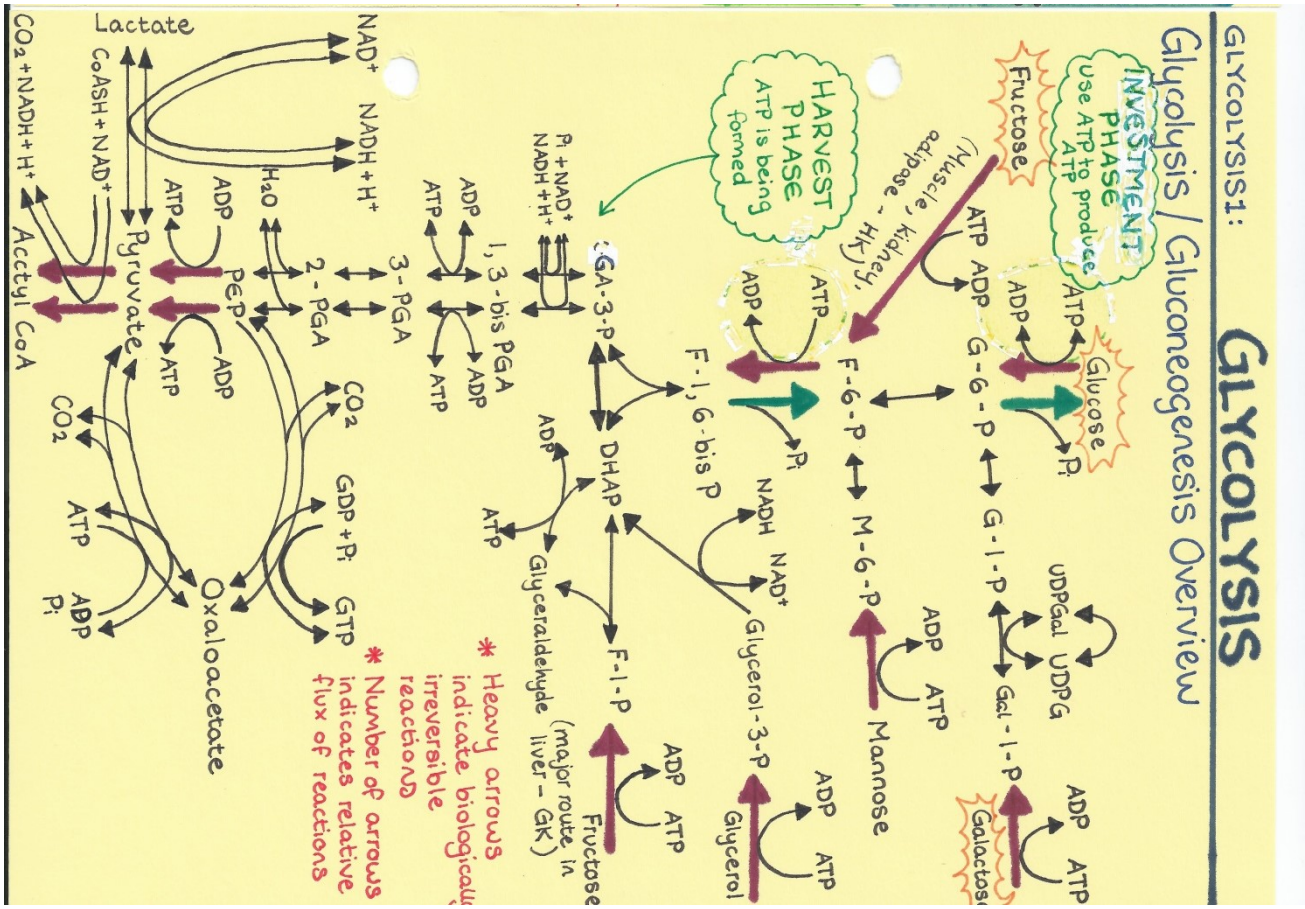
What is live high train low altitude (LHTL) training?
Live high train low altitude training is real or simulated altitude which allows for adaptation to hypoxia while keeping with the intensity of the training. In a real situation, this is achieved by the athlete living at high altitude (e.g. top of mountain) but have each training session at a lower altitude (go down mountain to train). In simulated altitude, altitude tents or barometric chambers can provide non-natural altitude for the athlete. In order for it to be effective, the athlete must be in the chamber for 14 hours a day.

What affect does altitude have on natives?
Natives are born and raised above 2500m and have greater tolerance for high altitude. Regarding performance, only three people have reached the top of Mount Everest 10 times and all three of these people were native Sherpas. Regarding hemoglobin (Hb) concentration, Bolivians (3900- 4000m) have slightly higher hemoglobin concentration than Tibetans (3800- 4065m) but Tibetans have equal hemoglobin concentration to sea level counterparts; therefore hemoglobin concentration is not performance related at altitude. As hemoglobin concentration is not performance related, it is agreed that natives have higher economy of movement, lung function and cardiac output to generate these increases in performance.

Do natives experience an increase in VO2max when they return to sea level?
Natives from moderate to high altitude do not experience great increases in performance when they are at sea level. This may be due to VO2max as their VO2max only increases by 25% on return to sea level which is only 2/3 improvement compared to non-natives.

What is overreaching?
An accumulation of training and/or non-training stress resulting in a short-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take from several days to several weeks.

What is overtraining?
An accumulation of training and/or non-training stress resulting in a long-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take from several w eeks to several months.



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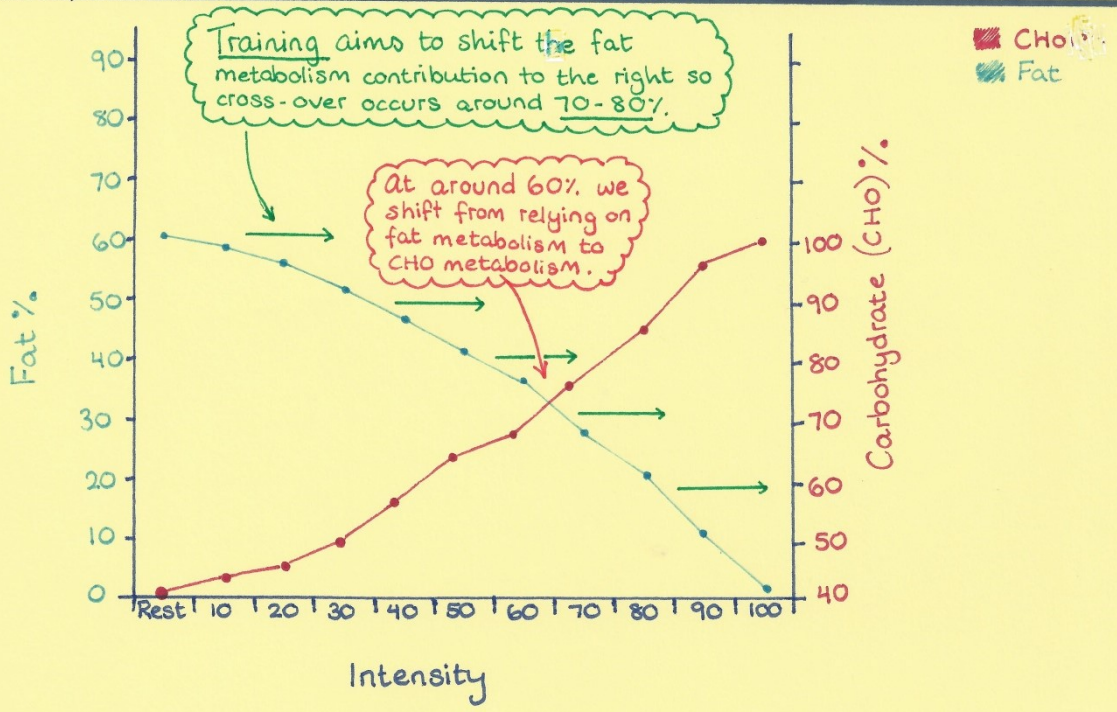
FAT METABOLISM 2: THE CROSS-OVER CONCEPT



RESPIRATORY SYSTEM: STATIC LUNG VOLUMES

Tidal Volume (TV)
Inspiratory Reserve Volume (IRV)
Expiratory Reserve Volume (ERV)
Residual Volume (RV) / ~~Reserve Volume~~
Total Lung Capacity (TLC)
Inspiratory Capacity (IC)
Forced Vital Capacity (FVC)

* TLC = TV + IRV + ERV + RV
* IC = TV + IRV
* FVC = TV + IRV + ERV

Static lung volumes are lung volumes that do not normally change unless lung disease is present.