Chapter 14

Reading Guide

1. Explain the many health benefits enjoyed by people who engage in regular physical activity.
2. Explain the physical activity pyramid.
3. Discuss recommendations by the Surgeon General and Institute of Medicine regarding the minimum amount of physical activity to reduce risk of disease. Be sure to read the "Nutrition Debate" at the end of the chapter to expand on this discussion.
4. Do you have to do all of your exercise at the same time for it to "count," or can you break it up into segments?
5. Explain the difference between flexibility, strength and cardiorespiratory endurance. (Be sure to see also the Harvard Exercise link)
6. What causes muscle hypertrophy? Atrophy?
7. What is the FIT principle; what are its components?
8. Discuss exercise intensity and heart rate.
9. Why are warm ups and cool downs important?
10. List at least three benefits of weight training. (Be sure to see also the Harvard Exercise link)
11.
12. List at least three benefits of cardiorespiratory training. (Be sure to see also the Harvard Exercise link)
13. Explain the fuel stores/processes that provide ATP during muscle activity in temporal order (ie, which process/fuel provides most ATP when).
14. What process/nutrient provides most ATP in a resting muscle cell? (Stated briefly in a quick sentence, but also exhibited in a graph)
15. Which types of exercises are powered more by anaerobic processes than aerobic?
16. Which types of exercises are powered more by aerobic processes than anaerobic?
17. What ARE the anaerobic processes? Aerobic?
18. Which types of exercises are powered more by glucose than by fatty acids? Which types are powered more by fatty acids than by glucose?

19. Which types of activities are associated with higher rates of lactic acid entry into the blood?
20. Discuss why fat is such a great way to store energy.
21. Explain what happens after about 20 minutes of moderate-strenuous activity in terms of the primary fuel source, and how minimal levels of glucose are maintained in the blood.
22. Explain some of the cellular changes that occur in muscle cells as they adapt to using more fat for fuel as a result of aerobic training.
23. Discuss the carbohydrate, fat and protein needs of athletes vs. moderately active people.
24. Are vitamin and mineral supplements necessary for active people eating a well-rounded, nutrient-dense diet?
25. What are some nutrients that MAY not be provided adequately in a healthy diet for active people?
26. What's the purpose of sweating during activity?
27. How can you reduce your risk of hyperthermia (overheating) during activity?
28. What fluid is recommended for active people during normal exercise? For endurance athletes during endurance trials?
29. Normally, are sports drinks necessary to replace electrolytes lost in sweat? When are sports drinks recommended?
30. Discuss ergogenic aids: the efficacy (whether it is known or not) and safety (known or not) of each. Which are safest? Most dangerous?

Supplemental Lectures

I. Overview of the Changes that occur in and around muscle cells when those muscle cells adapt to exercise:

-build more mitochondria and their enzymes
-build more contractile proteins
-increase tone; that is, a state of "readiness," this translates to an increase in metabolism and BMI.
-increase myoglobin and glycogen stores

-more blood vessels grow into the area

II. Muscle energetics

a. Resting muscle cells –

Resting muscle cells use primarily aerobic respiration (recall, TCA and ETC, all inside the mitochondria) to produce most of their ATP. In fact, resting muscle cells preferentially use fatty acids. So, the more muscle mass you have, the more FAT you burn just sitting there!

Anyway, at rest aerobic respiration can easily supply all ATP needed with average blood flow and mitochondrial activity. In fact, a resting muscle cell will make excess ATP to power it for the first few seconds of contraction. It will also take this resting time to store glucose as glycogen, and to store a substance call Creatine Phosphate (CP, see below)

b. When a muscle cell contracts-

When a muscle cell contracts, its energy requirements increase dramatically and immediately.

Now, not enough blood (with O2) is delivered to the cell to allow aerobic respiration to provide enough ATP, and glucose/fatty acids can't be split fast enough to produce enough ATP via aerobic respiration- YET. Soon, blood will be shunted to the active muscle, and once many glucose and fatty acids have been split, aerobic pathways will produce enough ATP for extended periods.

But, we're not there yet. We're at the very beginning of the contraction: the first second. I will tell you that even glycolysis is not fast enough to produce enough ATP to power the first several seconds of the contraction. So, how will the cell get enough ATP to get through these first few seconds, then into several minutes, and perhaps up to an hour or more?

i. First, the excess ATP is used. Only enough ATP can be stored to power a couple of seconds of contraction.

ii. Then the CP is split. What is CP? It's a high-energy molecule that can recharge ATP even faster than glucose can. The way CP works is this: after the first round of ATP splits, CP molecules split and reattach the ADP and Pi, regenerating the ATP. There is enough CP to get the cell through about 15 seconds of contraction.

    By the time stored CP is spent, glycolysis has really ramped up and will start taking over recharging ATP.

iii. Then glycolysis steps up- a muscle cell can be powered by glycolysis alone for a couple of minutes. In extremely intense activity, glycolysis provides most ATP for those couple of minutes. In that case, excess pyruvates are made. What happens to excess pyruvates?

iv. Finally, aerobic respiration steps up- if activity continues for more than a few minutes, aerobic respiration will start to provide the majority of the ATP. For the next 20 minutes or so, pyruvates from glycolysis, and some fatty acids, will provide the fuel for aerobic respiration. After about 20 minutes, fatty acids will provide most of the fuel for aerobic respiration (assuming moderate-intensity; with high intensity, more carbs are used).

Aerobic respiration can provide enough ATP for active muscle cells for hours, depending on the level of intensity of the exercise.

III. Protein synthesis and activity

Protein synthesis in muscle cells declines during activity. But, once activity ceases, protein synthesis increases. If the muscles have been "pushed" with strenuous activity, they will need to have little repair jobs on their contractile proteins and membranes. Plus, they will build more proteins to make sure the next time they are called upon for the same type of activity, they will be more prepared. So, with repeated demands placed on muscle cells, they will build more of the required structures, and become bigger and better at contracting. Some example proteins that are built: contractile proteins and enzymes required for glycolysis, cellular respiration, and making and breaking down glycogen.