Homeostasis Lab Additional Resources

Lesson 3: Homeostasis Lab

Physiological Parameters

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Heart Rate

Heart rate is controlled by a pacemaker—an area within the heart that initiates contractions of the heart muscles. If left alone, the pacemaker would set an unchanging beat. But when you exercise or sleep, for example, your heart needs to pump more or less blood through your body. Nerve cells within the circulatory system are able to detect changes in the chemistry of the blood. When blood contains too much carbon dioxide and too little oxygen, these cells send messages to the brain, which then sends instructions to the heart's pacemaker to pump faster. Chemicals in the blood can also trigger the pacemaker to pump faster or slower.

Respiration

The respiratory system exchanges oxygen and carbon dioxide between blood and the atmosphere. How fast you breathe is controlled mainly by the level of carbon dioxide in your bloodstream, which is monitored by an area at the base of the brain. Also, chemical receptors located near the heart monitor the levels of both carbon dioxide and oxygen in blood. The area of the brain that controls breathing has connections to the cerebral cortex. This is why you can control your breathing, but only to a point. When the level of carbon dioxide gets too high, you lose voluntary control of your respiratory muscles and inhale automatically. In other words, it is impossible to kill yourself by holding your breath!

Blood Pressure

Blood pressure is the pressure that blood exerts against the walls of a vessel. The amount of blood your heart pumps—how fast it pumps and how forceful each contraction is—is a major factor in determining blood pressure. There are other factors, too. The amount of blood in the body affects pressure, for example (less blood results in lower pressure). Also, the brain can alter the diameter of blood vessels, dilating (widening) them to reduce pressure and constricting (narrowing) them to increase pressure. The brain responds to signals it

receives from various cells throughout the body; some of these are sensitive to levels of oxygen and carbon dioxide, some are sensitive to chemicals, and some to blood pressure itself.

Perspiration

There are a number of ways your body maintains a constant temperature. When respiration rate increases, for example, heat from within your body is released with each exhalation. Water in the blood can also absorb heat and transport it to the skin, where the heat radiates into the surrounding air. But when you get really hot, perspiration is the most effective way that the body controls its internal temperature. As perspiration evaporates from the skin's surface, the skin is cooled. During strenuous activity, your body can release as much as 1.5 liters of sweat every hour.

Blood Sugar

It is important for your body to maintain a steady level of blood sugar. This level is kept steady by two hormones secreted by the pancreas, a gland found next to the stomach. One is insulin. Insulin lowers blood sugar by enabling sugar in the blood to enter the body's cells, where it is used or stored. The other hormone is glucagon, which, when released into the bloodstream, increases blood sugar level by converting some of the glycogen stored in the liver into glucose (sugar). Exercise often lowers blood sugar levels.

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NUTRIENT TIMING

Timing of nutrient intake depends on many variables, including the type of training (practice, strength, conditioning, or recovery), schedule, and the individual athlete's dietary preferences. Other variables include intensity and length of training, an active vs recovery day, and timing leading up to competition. Some endurance athletes may prefer a low-carbohydrate, high-fat diet as well. Intermittent fasting is also available to some athletes who are looking to lose fat and their training is later in the day, or they may supplement if their first training session is a resistance workout. Macronutrient timing is summarized in Table 4.

Table 4. Nutrient intake surrounding activity

When	Protein	Carbohydrate	Fat	Comment
Preexercise	20-30 g, especially for resistance training	200-300 g	Limit due to gastrointestinal distress	If an athlete is carbohydrate loading, he/she may consume 8-10 g/kg body weight/day for 1-3 days prior to competition
During exercise	Not needed	30-60 to 90 g/h depending on length of activity	Not needed	Hydration only if activity under 60 minutes. Should be liquid/gel-form carbohydrates for easy digestibility
Postexercise	20-30 g within 30 minutes	60-120 g within 30 minutes (1:3-4 ratio with protein)	In normal ratio with protein and carbohydrates	Continue refeeding with postworkout meal for regular refueling needs depending on exercise intensity

HYDRATION

Proper hydration is important for optimized performance, prevention of metabolic strain, and thermoregulation during exercise. Athletes should have a proper hydration strategy before, during, and after exercise based on their specific needs a fluid losses. Most authorities support athletes losing <2% body weight during activity, as more than that decreases cognitive function and performance. Thirst is often not a good indicator of dehydration, as an athlete can sometimes lose 1.5 L before thirst is perceived. Athletes may lose anywhere from 0.3 to 2.4 L per hour of sweat, and rates vary widely based on environment, sex, body size, and length of activity. Sweat comprises water, sodium, potassium, calcium, magnesium, and chloride, so athletes should replace both fluids and electrolytes with their recovery strategy. Hydration guidelines are summarized in Table 5.

Table 5. Summary of hydration guidelines

When	How Much to Consume	Comment
Preexercise	12-20 oz water or sport drink, 8 oz just prior to event	Consider small salty snack for fluid retention
During exercise	6-12 oz of water or sport drink every 15-30 minutes	No energy drinks. Consider sodium replacement in endurance events
Postexercise	16-24 oz of fluid for every pound lost	May obtain sodium and electrolyte replacement from a wide variety of foods

Pre-Workout Supplement Composition

Type of Supplement	Key Ingredient(s)	Effects on Homeostasis	Optimal Time to Take	Additional Info	Examples
Stimulant-Based Pre Workouts (e.g., Caffeine-Based)	Caffeine	Stimulants like caffeine are known to significantly increase heart rate and blood pressure during exercise. They enhance alertness and energy levels but can temporarily push the cardiovascular system. Caffeine can also increase thermogenesis, raising body temperature. Stimulants often increase the production of cortisol, which can be measured as a stress response.	30-45 minutes before a workout	At peak levels in the bloodstream, caffeine provides the most energy, focus, and elevated heart rate during your workout. Consume if you want to observe changes in heart rate, blood pressure, and cortisol levels.	C4 Original Pre Workout, Optimum Nutrition Gold Standard Pre-Workout, Yohimbine

Nitric Oxide Boosters	L-Arginine or Citrulline	These ingredients increase nitric oxide production, which dilates blood vessels, enhancing blood flow and reducing blood pressure during exercise Improved blood flow can also help with oxygen delivery to muscles, which may buffer the buildup of lactic acid, affecting acid-base balance.	30-45 minutes before a workout	These compounds need time to increase nitric oxide levels and dilate blood vessels for better blood flow, oxygen delivery, and pump during exercise. Consume if you want to measure changes in blood pressure and vasodilation.	Cellucor NO3 Chrome, Kaged Muscle Pre-Kaged, L-Arginine, Citrulline Malate
Beta-Alanine-Based Pre-Workouts	Beta-Alanine	Beta-alanine increases carnosine levels in muscles, which helps buffer hydrogen ions produced during high-intensity exercise. This can help maintain muscle pH levels, delaying fatigue. Beta-alanine can lead to a higher tolerance to lactic acid buildup, temporarily affecting your body's pH levels post-exercise.	30-45 minutes before a workout	Beta-alanine takes about 30 minutes to start buffering lactic acid in the muscles. Its effects build over time, but you will feel its tingling sensation (paresthesia) shortly after consumption. Consume if you're interested in seeing changes in pH balance and muscle hydration.	Bulk Pre-Workout by Transparent Labs, PEScience High Volume
Creatine-Based Pre-Workouts	Creatine Monohydrate	Creatine draws water into muscle cells, which may affect hydration levels and electrolyte balance. This could be	30-60 minutes before a workout	Creatine works more effectively when it's built up in the muscles, but taking it pre-workout ensures that	Optimum Nutrition Micronized Creatine, MuscleTech Cell-Tech

		measured in terms of water retention or osmotic balance. Creatine influences ATP production in the body, which may result in more sustained performance but also a shift in energy metabolism during intense exercise.		your muscles are saturated and ready for high-energy output. Creatine helps with ATP production, which is immediate during high-intensity exercise. Consume if you're interested in seeing changes in pH balance and muscle hydration.	
Thermogenic Pre-Workouts	Caffeine, Green Tea Extract, Yohimbine	Thermogenic pre-workouts enhance fat oxidation and can increase body temperature, which might trigger more sweating and potentially affect electrolyte balance. The stimulants in them will also increase heart rate and overall metabolic rate, impacting homeostasis measures like heart rate variability.	30-60 minutes before a workout	These ingredients kickstart your metabolism and body temperature, providing increased fat burning and energy expenditure during your workout. Consume if you're looking to observe changes in body temperature and metabolic rate.	Green Tea Extract, Capsaicin Evlution Nutrition ENGN Shred, RSP Nutrition DyN.O.
Carbohydrate-Based Pre-Workouts	Dextrose, Maltodextrin	Pre-workouts with fast-digesting carbs can increase blood glucose levels rapidly. Monitoring the rise and fall of blood sugar during and after exercise would show significant	15-30 minutes before a workout	Fast-digesting carbs like dextrose or maltodextrin are absorbed quickly, providing a fast spike in blood glucose to fuel your workout. Taking them too early may cause a crash in energy	Vitargo, Gatorade Prime Energy Chews

		shifts in glucose homeostasis.		levels before exercise begins. Consume if you want to track shifts in blood glucose levels.	