Anatomy and Physiology

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During exercise, significant regulations are required in cardiovascular system in order to maintain the heart rate and sufficient supply of oxygen to all body parts. These adjustments include increase in heart rate and cardiac contractions which ultimately result in increased cardiac output. Enhanced cell metabolism results in increased blood flow (Korthius, 2011). This blood regulation in cardiovascular system is required for delivery of oxygen and nutrients from blood to the muscles and removal of carbon dioxide. The changes in consumption of oxygen and manifold increased cardiac output may result in structural changes in left ventricle which increases stroke volume and the end-systolic volume in the ventricles decreases (Kudomi et al., 2019). These processes help regulate the supply of oxygen and reducing carbon monoxide during excessive exercise (Joyner & Casey, 2015).

Exercise affects the concentration of urine such that pulmonary absorption level is higher in the course of exercise which results in increased pulmonary blood flow thus increased alveolar permeability (Haase et al., 2016). Dehydration results in concentrated urine as higher level of circulating antidiuretic hormone (ADH) reduces renal free clearance of water (Garrahy, Cuesta, & Thompson, 2018). Reabsorption of water causes decreased urine output and increase in the volume of blood which ultimately results in decreases osmosis thus highly concentrated urine. But the low level of ADH decreases water absorption and permeability and plasma osmolality decreases to maintain a balance in osmoregulation in kidneys (Meltzer, 2019). Plasma osmolality helps sustain the volume of the fluids and normal cell functions. During dehydration the urine osmolality is extremely high so high intake of water can regulate the water balance in the body by increasing plasma volume (Yeun & Depner, 2010).

During exercise, heart needs to pump faster to supply energy to the skeletal muscles. In order to ensure the enough blood supply, the skeletal muscles undergo sympathetic vasoconstriction and the phenomenon is termed as andrenergic functional sympatholysis (Fisher & Secher, 2019). It induces nervous system so that maximum blood flow is diverted towards skeletal muscles. It can be used as a means of measurement of blood pressure and if it remains high consistently, it can lead to blood clotting or damaging cardiac muscles. (Hearon, Kirby, Luckasen, Larson, & Dinenno, 2016). In such conditions systematic vascular resistance helps the blood flow move towards skeletal muscles. As during exercise, the carbon monoxide level increases thus decreasing the absorption of oxygen in hemoglobin. Calcium is an important element for electrical conductivity of cardiac muscles. The calcium blockers inhibit the calcium exchange thus preventing the conductivity and vasoconstriction (Gordan, Gwathmey, & Xie, 2015). The normal heart rate of an average induvial is 72, and during exercise it can exceed up to 149 and increased stroke volume and cardiac input. Electrical conductivity stimulates the contraction of ventricles and ensures enough oxygen supply for the muscles and discharge of carbon dioxide (Tse, Lai, Yeo, Tse, & Wong, 2016).

The process of glycogenesis is highest while fasting as at that time liver cells produce excess glucose by the conversion of lactic and amino acids. Patients suffering from diabetes mellitus have extremely high levels of plasma glucose and ketoacidosis and results in decreased blood pH level (Beshyah, Chowdhury, Ghouri, & Lakhdar, 2019). As the pancreas do not produce sufficient insulin, liver produces ketones by converting fatty acids while fasting that can be used a s source of energy (Wang et al., 2015). Active metabolism in kidneys secrete acids and are involved in reabsorption of bicarbonates that increase pH and bind with hydrogen ions forming carbonic acid (Maiuolo, Oppedisano, Gratteri, Muscoli, & Mollace, 2016). In order to normalize the pH, faster breathing can help exhale excess carbon dioxide decreasing hydrogen concentration. The normal respiratory pH is around 7, acidic is less than 7 and alkali is greater than 7. The normal pH of partial pressure of carbon dioxide is considered to be 35 to 45 (Versteeg et al., 2017). Increased respiratory condition is termed as hyperventilation where additional carbon dioxide is exhaled off which results in decreased amount of hydrogen in blood leading to alkalosis. In diabetic patients, ketones being acidic in nature cause metabolic acidosis in blood (Hörber et al., 2018).

Heavy exercise causes the swift of air out of lungs because of rapid breathing. Quick breathing compensates the oxygen supply and the inspiratory capacity is changed due to increase in tidal volume. But there is a maximum vital capacity to the amount of air breathed during excessive metabolic activities and exceeding that point may cause damage to the lungs. During normal breathing, the intercostal muscles stiffen the chest lining for the exchange of air. (Kranke et al., 2015) In the case of excess air inhaling, the tidal volume increases and thus increasing the rate of respiration. Emphysema is the damaging of alveolar walls due to extreme loss of oxygen and the lining is so narrowed that no air can be passed through it leading to lungs damage (Shah, Herth, van Geffen, Deslee, & Slebos, 2017). Kidneys produce erythroprotein for the production of erythrocytes to increase hemoglobin level in blood thus increasing the uptake of oxygen. In the case of blood transfusions, immune system might attack the new cells and cause kidney failure. High blood cells level help the breathing at higher altitudes (Yan, Yixuan, Maolin, Zhang, & Jian, 2018).

**References**

Beshyah, S. A., Chowdhury, T. A., Ghouri, N., & Lakhdar, A. A. (2019). Risk of diabetic ketoacidosis during Ramadan fasting: A critical reappraisal. *Diabetes Research and Clinical Practice*.

Fisher, J. P., & Secher, N. H. (2019). Chapter 24—Regulation of Heart Rate and Blood Pressure During Exercise in Humans. In *Muscle and Exercise Physiology* (pp. 541–560). Academic Press.

Garrahy, A., Cuesta, M., & Thompson, C. J. (2018). Physiopathology, Diagnosis, and Treatment of Inappropriate ADH Secretion and Cerebral Salt Wasting Syndrome. *Hypothalamic-Pituitary Diseases*, 405–431.

Gordan, R., Gwathmey, J. K., & Xie, L.-H. (2015). Autonomic and endocrine control of cardiovascular function. *World Journal of Cardiology*, *7*(4), 204.

Haase, C. B., Backer, V., Kalsen, A., Rzeppa, S., Hemmersbach, P., & Hostrup, M. (2016). The influence of exercise and dehydration on the urine concentrations of salbutamol after inhaled administration of 1600 µg salbutamol as a single dose in relation to doping analysis. *Drug Testing and Analysis*, *8*(7), 613–620.

Hearon, C. M., Kirby, B. S., Luckasen, G. J., Larson, D. G., & Dinenno, F. A. (2016). Endothelium‐dependent vasodilatory signalling modulates α1‐adrenergic vasoconstriction in contracting skeletal muscle of humans. *The Journal of Physiology*, *594*(24), 7435–7453.

Hörber, S., Hudak, S., Kächele, M., Overkamp, D., Fritsche, A., Häring, H.-U., … Heni, M. (2018). Unusual high blood glucose in ketoacidosis as first presentation of type 1 diabetes mellitus. *Endocrinology, Diabetes & Metabolism Case Reports*, *2018*(1).

Joyner, M. J., & Casey, D. P. (2015). Regulation of increased blood flow (hyperemia) to muscles during exercise: A hierarchy of competing physiological needs. *Physiological Reviews*, *95*(2), 549–601.

Korthius, R. J. (2011). Chapter 4: Exercise Hyperemia and Regulation of Tissue Oxygenation During Muscular Activity. In *Skeletal Muscle Circulation*. Morgan & Claypool Life Sciences.

Kranke, P., Bennett, M. H., Martyn‐St James, M., Schnabel, A., Debus, S. E., & Weibel, S. (2015). Hyperbaric oxygen therapy for chronic wounds. *Cochrane Database of Systematic Reviews*, (6).

Kudomi, N., Kalliokoski, K., Oikonen, V., Han, C., Kemppainen, J., Sipilä, H. T., … Heinonen, I. H. (2019). Myocardial blood flow and metabolic rate of oxygen measurement in the right and left ventricles at rest and during exercise using 15O-labeled compounds and PET. *Frontiers in Physiology*, *10*, 741.

Maiuolo, J., Oppedisano, F., Gratteri, S., Muscoli, C., & Mollace, V. (2016). Regulation of uric acid metabolism and excretion. *International Journal of Cardiology*, *213*, 8–14.

Meltzer, J. S. (2019). Renal physiology. In *Pharmacology and Physiology for Anesthesia* (pp. 782–794). Elsevier.

Shah, P. L., Herth, F. J., van Geffen, W. H., Deslee, G., & Slebos, D.-J. (2017). Lung volume reduction for emphysema. *The Lancet Respiratory Medicine*, *5*(2), 147–156.

Tse, G., Lai, E. T. H., Yeo, J. M., Tse, V., & Wong, S. H. (2016). Mechanisms of electrical activation and conduction in the gastrointestinal system: Lessons from cardiac electrophysiology. *Frontiers in Physiology*, *7*, 182.

Versteeg, R. I., Stenvers, D. J., Visintainer, D., Linnenbank, A., Tanck, M. W., Zwanenburg, G., … Serlie, M. J. (2017). Acute effects of morning light on plasma glucose and triglycerides in healthy men and men with type 2 diabetes. *Journal of Biological Rhythms*, *32*(2), 130–142.

Wang, B., Ding, Z., Wang, W., Hwang, J., Liao, Y.-H., & Ivy, J. L. (2015). The effect of an amino acid beverage on glucose response and glycogen replenishment after strenuous exercise. *European Journal of Applied Physiology*, *115*(6), 1283–1294.

Yan, S. H. I., Yixuan, W., Maolin, C. A. I., Zhang, B., & Jian, Z. H. U. (2018). An aviation oxygen supply system based on a mechanical ventilation model. *Chinese Journal of Aeronautics*, *31*(1), 197–204.

Yeun, J. Y., & Depner, T. A. (2010). Principles of hemodialysis. In *Chronic Kidney Disease, Dialysis, and Transplantation* (pp. 277–302). Elsevier Inc.