SUBMITTING ILLUMINATIONS FOR REVIEW

As educators, we are continually designing new methods and procedures to enhance learning. During this process, good ideas are frequently generated and tested, but the extent of such activities may not be adequate for a full manuscript. Nonetheless, the ideas may be quite beneficial in improving the teaching and learning of physiology. Illuminations is a column designed to facilitate the sharing of these ideas (illuminations). The format of submissions is quite simple: a succinct description of about one or two double-spaced pages (less title and authorship) of something you have used for the classroom, teaching, lab, conference room, etc. You may include one or two simple figures or references. Submit ideas for inclusion in Illuminations directly to the Associate Editor in charge, Stephen DiCarlo (sdicarlo@med.wayne.edu).


Spirometry: simulations of obstructive and restrictive lung diseases

Pulmonary function testing by use of spirometers is useful for enhancing students’ understanding of normal lung volumes, capacities, and flow rates. Furthermore, the spirogram can be an excellent tool for understanding how lung diseases alter lung volumes, capacities, and flow rates. To facilitate this understanding, physiology programs at several schools have students determine their normal lung volumes, capacities, and flow rates by means of standard spirometry procedures (1). Subsequently, these programs have students simulate obstructive and restrictive lung diseases and repeat the procedures for pulmonary function testing. To simulate an obstructive impairment, a rubber stopper, with a small hole drilled through the center, is placed securely into the spirometer tubing. The stopper adds resistance to inspiration; however, the resistance to expiration is most dramatic. The restrictive impairment is simulated by tightly securing a weight lifter’s belt around the student’s thorax after he/she has expired toward residual volume. The belt limits chest expansion during inspiration. The resulting spirograms closely resemble typical nor-

FIG. 1. Representative spirograms for normal (A), simulated obstructive (B), and simulated restrictive (C) diseases.
mal, obstructive, and restrictive curves (Fig.1). The spirometry exercise enhances students’ understanding of pulmonary physiology and pathophysiology, as well as allowing them to experience the difficulty, discomfort, and apprehension associated with lung disease.

References


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Propagation of action potentials in myelinated vs. unmyelinated neurons

For invertebrates, propagation of action potentials down unmyelinated axons is sufficient for rapid conduction. For faster propagation velocities, the axon becomes larger in diameter. However, increasing the speed of action potentials by increasing the diameter of the axon is not feasible in vertebrates. Squid giant axons are up to 1 mm in diameter and have very rapid propagation velocities. Mammalian nerves have about 400 fibers in the same cross-sectional area as the squid giant axon. Thus, if each of the fibers were as large as the squid giant axon, each mammalian nerve would be approximately 2 cm in diameter! Thus, vertebrates have evolved another mechanism for increasing nerve conduction: wrapping the axons in insulating membranes of a myelin sheath. Some axons have as many as 150 wraps of Schwann cells around them, thereby increasing the effective thickness of the axonal membrane 100-fold and eliminating ion leaks across cell membranes except at the periodic gaps called Nodes of Ranvier.

Undergraduate physiology or biology students at the University of South Dakota do not forget the differences between propagation of action potentials by saltatory (saltāre is the Latin verb ‘to leap’) conduction and by regular conduction. We have used a visual demonstration of the differences. The key component of the demonstration is that the instructor is the one who demonstrates the differences!

For regular conduction of action potentials in unmyelinated axons, the instructor walks by “baby steps” across the stage.

For saltatory conduction of action potentials in myelinated axons, the instructor leaps or leapfrogs rapidly across the stage.

The instructor has the students compare the time and distance covered for three baby steps vs. three leaps.

An additional approach is to describe a castle that is protected by a great surrounding wall that has watch towers at regular intervals. The students are told that if this fortress is attacked, leaping signals of light from tower to tower would be the fastest way to alert the guards. For example, the first guard lights a torch, and once the guard in the next tower sees the light he lights his torch. This leaping light from tower to tower is faster than sending a runner along the wall. This is a simple scenario to demonstrate. Line students up with flashlights at approximately equal distances along the length of the room. Have a runner next to the first student holding a flashlight. Record the time required for the student to run the distance vs. the time required for the light to leap from student to student.

Or ask: why did some Native American people use smoke signals to communicate across long distances? Because the signal leaped from place to place faster than sending a runner.

These physical demonstrations make quite an impression on the students, particularly since the first time we used the demonstration the instructor actually fell off the stage. Students have always been able to identify and describe the concept later on exams.

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