S STUDENTS

National Student Team Contest (first stage)
Solution of task 3. Heart studies

1. Under hypoxia due to the lack of O_2 – final electron acceptor in respiratory (or electron-transport chain, ETC) – there is the elevation in the amount of reduced electron carriers in ETC (since there is no way to give an electron). The reduction of ETC complexes will stop ETC function and, as a result, will stop ATP synthesis. In its turn, absence of ATP causes stopping of cardiomyocyte contractions. The stop of ETC will cause the accumulation of NADH and FADH2 and will slow down the rate of the Crebs cycle and beta-oxydation of fatty acids. Under reoxygenation the rapid and acute flow of O_2 will trigger formation of reactive oxygen species (ROS), since electrons will go to the O_2 molecules from complexes I and III that are overfilled with electrons. The elevation of ROS will cause oxidative stress in cytoplasm – oxidation of various cell molecules, including DNA. Besides, oxidation of ETC complexes leads to the formation of PMP (permeability mitochondria pore) and cytochrome c exit to the cytoplasm with the initiation of apoptosis.

2. Any molecules that can scavenge ROS: beta-carotene, vitamin A, E, etc.

3. Raman spectroscopy can be used for the selective study of cytochromes. Laser excitation at 532 nm will excite Raman scattering from cytochromes c and b-type in ETC, laser with 633 nm wavelength will excite Raman scattering of cytochromes a. Raman spectra od cytochromes depend on their redox state, so by characteristic Raman peaks it is possible to monitor change in the relative amount of reduced cytochromes.

4. This can also be done by Raman spectroscopy. Thus, Mb molecules have highly specific Raman scattering. Under laser excitation at 532 nm it is possible to record Raman scattering from all Mb forms in cardiomyocyte cytoplasm and to tell about the relative amount of oxymyoglobin. The increase in the amount of oxyMb will correspond to the restoration of the blood low to the studied region in a heart.

5. Colchicine interacts with tubulin preventing its polymerization and formation of microtubules thus interferring any cell activity associated with microtubules. Availability of tubulin is essential for the mitosis, so colchicine stops the mytosis. Colchicine is known to have anti-inflammatory action since it inhibits neutrophil motility and activity. To decrease its toxicity many researchers try to develop non-toxic cages that will encapsulate colchicine preventing its gastrointestinal side-effects.