

CARDIAC MUSCLE AND THE SYMMETRY

V.D. Tsvetkov

Institute of Theoretical and Experimental Biophysics,
RAS, Pushchino, Moscow 142292 Russia

The system of capillary oxygen supply of myocard provided the “quantity” and “quality” of utilized oxygen adequately to the heart activity.

The mean cell of this system can be presented in form of a sequence of right prisms having square bases, with four parallel capillaries forming the edges. The muscle tissue (filament) located inside prisms. The capillaries are arranged along the prism edges so that, relative to a given capillary, the

arterial and venous ends of two adjacent capillaries (edges) are capillary half-length shifted up and down. During the tension (systole) and relaxation (diastole) of myocard, the distances between the prism edges vary inversely with variation in the rate of oxygen utilization.

All sections of “systolic” and “diastolic” prisms perpendicular to the capillaries consume the same amounts of oxygen for unit time, regardless to level of heart activity. This phenomenon is an invariant of the “quantitative” oxygen supply to cardiomyocytes at any level of heart activity [1].

The density function of pO_2 is analogous in all cross sections of tissue prism in course of cardiac cycle. Changing the level of heart activity causes all elements of pO_2 density functions in all sections to change by the same $P02$ value, which is adequate to new level. At any level of heart activity, the difference between the maximal and minimal pO_2 values remain constant in all sections. This difference represents an invariant of “quantitative” oxygen supply to heart [1].

The cross sections having the analogous co-ordinate point set of pO_2 are repeat every two capillary lengths along the whole sequence of tissue prisms, with symmetry of parallel translation taking place. Every half-length of a capillary, the co-ordinate point set of pO_2 in the section “turn” by 90° , i.e. the turning symmetry takes place [1].

This, the density function of pO_2 in sequence sections along the muscle filament obeys the spiral symmetry. Due to this fact, all cardiomyocytes are in equal “oxygen” conditions, which are adequate to the level of heart activity.

1. Tsvetkov V.D. Heart, the golden section and symmetry. Pushchino, 1997. 170 p.