The theory of recttification in biological systems

A. Dani,[1] P. Szendrő[2]

[1]Lausitzer Seenland Klinikum, Hoyerswerda, Germany, [2]Faculty of Mechanical Engineering, Szent Istvan University, Gödöllő, Hungary. Corresponding author: e-mail: arpad.dani@seenlandklinikum.de , onkohelp@yahoo.com

Abstract. The theory of biological rectification originated from the study of physiological processes of the human body. Biological processes are defined by certain structures; biological rectification is achieved by biological structures too. These rectifying biological structures are the biological rectifying valves, a definition adopted from physics. An extension of this notion leads to a generalization of the rectification phenomena in biological systems. The practical value of this theoretical concept is widely presumed. Here we show that the loss of rectification may result in dysfunction or even destruction of the biological system, the rectification implies the simplification of biological processes, reduce the utilization of energy in biological systhems and in general can help in understanding the processes in the human body and biology better. We hope that experts of different scientific fields will probably confirm or disprove this hypothesis.
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Introduction

The theory of biological rectification is a generalization of a biological process that has not yet been emphasized well. The word "rectification" has several meanings. The most well-known definition is used in electricity but this word is also used in geology, civil engineering, graphic arts and so on. The phenomenon of rectification has been described in certain biological processes, for example, in ion channels [1, 2], electrical synapses [3, 4] or in connection with kinesin [5].

Biological Rectification (BR)

Every independent biological process has a more-or-less defined starting and end point. As these processes always advance from the starting to the end point, the progression of the events are one-way, that is, the progression is rectified. This can be seen in human system: swallowed food goes through the alimentary tract, urine is discharged from the kidneys, neural stimuli are transferred from the brain to the peripheral nerves or vice versa, people's life continues from birth until death and so on. In nature, everything has a definite reason and a purpose. Supposing biological processes are rectified, it must also be assumed that this one-way progress is defined by something, that`s the biological rectification (BR).

The position of the BR in biological systems

The second law of thermodynamics establishes that energy is always transferred from a state of higher energy to another state of lower energy. The same thing happens in the biological systems too. A living organism is an unpredictable system. Its non-equilibrium is obtained from the environment, which possesses a greater degree of non-equilibrium than the living organism. When a living organism loses its ability, as a singular system, to hack into environmental no-equilibrium, it turns into a more equilibrated system; that is to say, it dies. All biological processes are irreversible and unwavering progressions. All natural processes take place on the route of Entropy, whose unidirectional trajectory is determined by the flow of Time. (10). A special interest in the irreversible thermodynamic became the study of non-equilibrium steady states, in which entropy production and some flows are non-zero, but there is no time variation (12). When an open system is in conditions that allow it to reach a stable stationary thermodynamically non-equilibrium state, it organizes itself so as to minimize total entropy production defined locally. This stable stationary thermodynamically non-equilibrium state is the Life. Life is not a force or a kind of energy, but a state of quantum energy. Optimally this,, conditions" allows to reach some stable states with minimal or zero energy, but in most of the cases the biological system must interact very efficiently with the environment in order to reach

and maintain this stable state. Efficiency means self organisation. According to our view, in this self organizing process has the biological rectification (BR**)** a great role.

Biological rectifying valves (BRV)

Biological processes are defined by certain structures, which also mean that biological rectification is achieved by biological structures too. Referring to these rectifying biological structures as biological rectifying valves (BRV*),* an example of BRV is the venous valve presented in Figure 1, while other examples include the valves of the heart or valves in the lymphatic vessels.

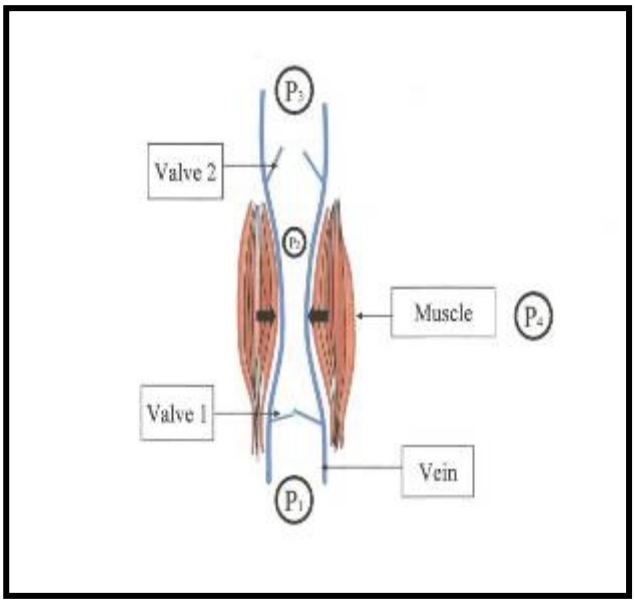

Fig.1. The venous valves as biological rectifying valves

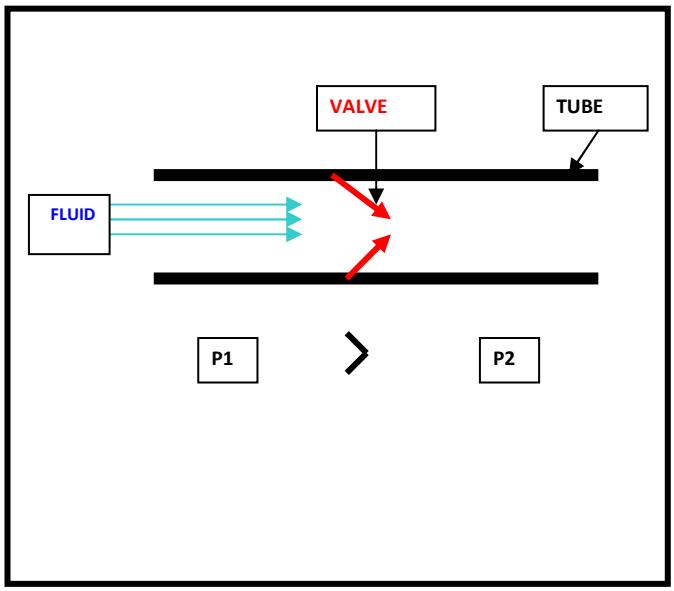

Fig.2. The physical rectifying valve

The definition was adopted from physics*:* a physical rectifying valve (Fig.2) is a valve that permits the flow of the liquid, gas or semi-solid material in only one direction. Biological rectification as a function is mediated by biological valves as structures. However, the existence of certain structures suggests certain functional characteristics, indicating that the identification of biological valves can help in justifying the hypothesis of biological rectification. Moreover, the more processes that are shown to be rectified, the more general the theory of biological rectification becomes.

Materials and Methods

A MEDLINE and INTERNET search was performed, using the keywords „rectification", „biological rectification" , „irreversibility in biology", „unidirectional evolution".

Results and Discussion

BR in Human System

The hypothesis of biological rectification originated from the study of the human body. The evaluation of transport of fluids (urine, blood or lymphatic fluid) and solid materials (food or feces) provided the generalization of rectification to several systems of the body (the circulatory system, the lymphatic system, urinary tracts and the alimentary tract). The study of physiological processes of the human body and the (to date, partial) evaluation of the relevant literature suggested the conclusion that rectification can be traced in other systems of the body

(for example, the nervous system) (4) and most, if not all, physical and chemical processes are also rectified (cellular membrane transport) (5).

Generalization of BR

In order to make the hypothesis of BR general, the definiton of BRV must be widened and the following new entities must be introduced:

The biological valve structure (BVS)

It is very important to emphasize that anatomical structures similar to physical valves are not the only ones that can work as rectifiers. Rectification can also be carried out by special geometrical arrangement of certain anatomical structures, e.g., the biological valve structure. A good example is the anatomical unit of the ureterovesical junction (Fig.3).

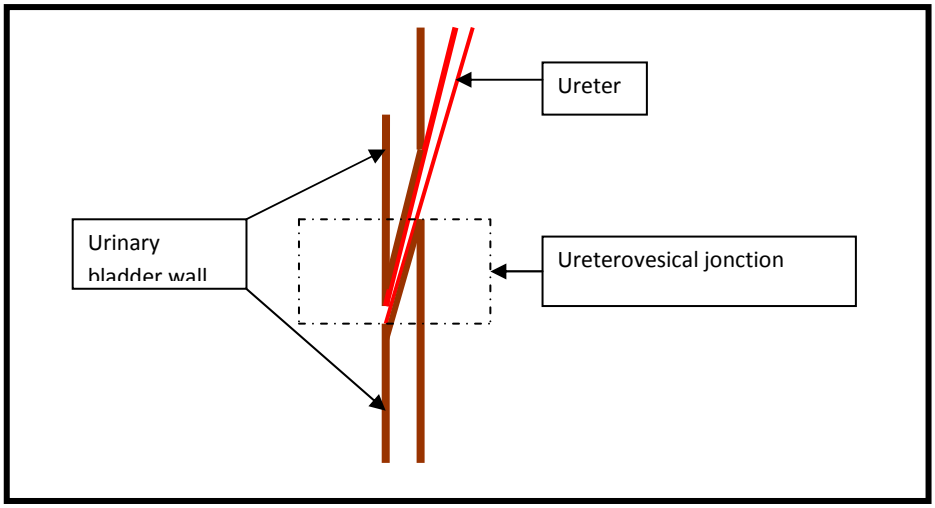

Fig. 3. The ureterovesical junction as biological valve structure

The ureter passes through the wall of the urinary bladder obliquely so the increasing intravesical pressure can close the distal segment of the ureter, even though there is not any valve-like structure. Other examples of the biological valve structure are the cardia, the pylorus, the Bauhin's valve in the alimentary tract.

The biological valve effect (BVE)

The biological valve effect means the generalization of the idea of biological valves. Every biological process, which drives the function (or the existence) of a certain biological system exclusively in one direction, is a process with a biological valve effect. Examples of the biological valve effect are the mucous membrane of the intestines, that allows nutritive adsorption in only one direction, the neuronal synapses, as the stimuli can be transferred only in one direction, the endocrine regulation (in human system) of puberty or menopause, as well as the sophisticated mechanism of apoptosis.

Other structures in biological systems with the same function

Ramakrishnan N. *et al*. (6) described biochemical switches (*BVS?*) as a functional module. They found nearly 4,500 reaction topologies that demonstrate switching behavior. Just as a computer memory unit can store a bit of 0 or 1 through electrical signals, a biochemical switch can be in one of two states, where chemical signals are on or off. This lets the cell record the presence/absence of an environmental stimulus, the level of a signaling molecule, or the result of a cell fate decision. This switches opens up new bioinformatics approaches to understanding cellular decision making and cellular memory. Gil *et al*. (11) in their study bridges an important gap between the genetic architecture of a regulatory network and the functional requirement for

robust unidirectional cell cycle transitions. In this study, they demonstrate that, in budding yeast, transcriptional positive feedback—a regulatory system in which a protein promotes transcription of its own gene—of the G1 cyclins Cln1,2 (*BRE?)* is the critical determinant for irreversible entry into a new cell cycle. This commitment, once made, means the new cycle of division cycle cannot be aborted and must be successfully completed. Novak *et al*. (7) has been proved that irreversible transitions in the cell cycle (or in any other molecular control system) cannot be attributed to a single molecule or reaction, but that they derive from feedback signals in reaction networks.

The period of biological valve

Biological systems are different in their complexity, and accordingly, there are a different number of BVRs in them. The effects of the rectification carried out by these BVRs define the lifespan of the biological system. Time, as a one-direction factor, is a very important feature of biological processes. The factor of time, as a characteristic of biological rectification, can be introduced into this theory by the definition of the period of the biological valve. The period of the biological valve is the period in which the particular biological process or system is between two neighboring rectifying biological valves.

The absence of BR in human systems and The absence of BR in biological systems

In the introduction of this paper, we supposed that everything has a purpose and a reason in nature. According to this idea, we must answer the question: what is the role of BR?**.** In the studied fields (human body, transport of fluids and nutritives), we can conclude the following important fact of experience: the disturbance of rectification results in diseases (for example circulatory disorders, retention of urine and bowel obstruction). Generalizing, we can state that every disturbance in the rectified processes of the human body, or the cessation of rectification, leads to illnesses while permanent failure in rectification usually elicits death. On the other hand such illnesses may be cured by the restoration of rectification.

Supposing the theory of BR is true, rectification is a primary condition of the normal functioning of biological sytems and the loss of rectification can result in dysfunction or even destruction of the biological system. For the restoration of normal function, rectification must be restored, which requires the identification of biological valves, valve structures and the valve-effect. The repair of the malfunction would suggest the functional and/or structural restoration of these units.

The role of BR in the simplification of biological processes and The role of BR in the utilization of energy

The BR meens also a simplification of biological processes. With the help of this theory, the evaluation and understanding of certain biological processes may become easier. In our opinion**,** BR is the main process behind reflexes and automatic biological functions, in addition in regulating the biological clock too, among others. Every simplification saves energy, which is why BR can influence the energy-requirements of biological systems significantly by minimizing these requirements.

Other (negative) effects of BR

The verification of BR can carry unpleasant information for humans and biological systems in general. In human systems, it means malignant cells cannot be (re)transformed into benign cells, for example, so the only possible way of therapy is the destruction of these cells. For the same reason, it is also impossible to stop aging as every system advances towards its end with time (8,10).

Conclusions

In our opinion, BR is a true process. Biology is so complex that it is very difficult to point out correct findings based on our limited knowledge. Experts of different scientific fields will probably confirm or disprove our hypothesis. Study of BR can expand the understanding of

biological systems and may help in the diagnosis and repair (treatment) of malfunctions (diseases) of these biological systems (the human body).
Further research is neccessary for a better understanding of the process of biological rectification.

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