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Thermodynamics of Irreversible Processes; Centralized Aerobic-Anaerobic Energy Balance Compensation; Biodegradation; Biosynthesis

Abbreviations

TIP: Thermodynamics of Irreversible Processes; CAAEBC: Centralized Aerobic-Anaerobic Energy Balance Compensation

Short Communication

Time to Take the Thermodynamics of Irreversible Processes into Consideration to describe *in vivo* Biodegradation

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Abstract

Contemporary studies usually consider in vivo biodegradation as the unidirectional asymptotic process that could be approximated by a hyperbola-style equation. Recent observations demonstrate, that this process should be considered rather as an interaction of both synthesis and decay. These observations, probably, possess deeper roots in the thermodynamics of irreversible processes (TIP) which allows considering life-associated processes in connection with dissipative structures, distributing energy from the flow organized by centralized aerobic-anaerobic energy balance compensation (CAAEBC) system. In our review, we propose to take a wider and deeper view of in vivo biodegradation from this viewpoint.

Introduction

Quite a while ago a versatile tool to study processes associated with energy flows – TIP – started its development after the pioneer ideas of Prigogine [1]. His Dissipative structure theory let find a way to connect self-organization with some thermodynamic functions [2-4]. Before thermodynamics looked rather like thermostatics. It shows the probability to choose certain direction(s) only. The proposed by Prigogine approach opened fresh view on the formation and stepwise increment of biological entities complexity [5-7]. In parallel, there was a development of the autocirculation in vitro concept in Chemical kinetics from the discovery of Belousov his famous reaction which visually demonstrated by color change oscillations [8]. Later there were some other examples of such oscillators like the Sel'kov reaction [9]. The most important in the later development of the issue is the observation of how different is the complexity of the contemporary scheme [10] from the starting one [8]. It is getting quite obvious that attempts to describe such oscillators in vivo will face a drastic increment of the volume of calculations. Nevertheless, some reports demonstrate rather successful descriptions in case modeling has a restricted level of process consideration [11]. With the increment of the interest in the description of the biodegradation in vivo it is necessary to step to the TIP and start to consider it as a superposition of decay and synthesis that could sometimes generate the above-mentioned oscillations [12,13].

Discussion

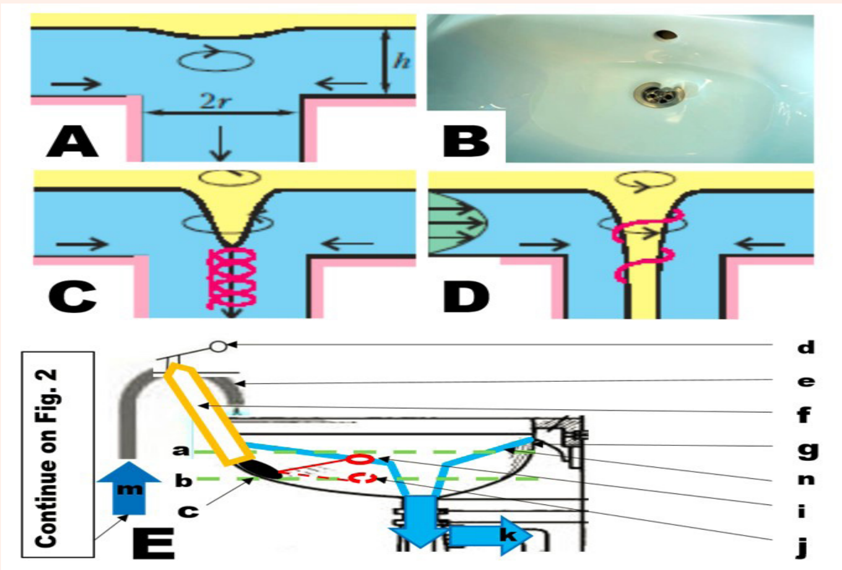

Figure 1: **The modeling of living organism energy flow through CW. A - the start of whirlpool formation by the water of level h flowing from sink with the 2r diameter hole. B - the real view on the CW at the early stage. C and D - different stages of CW development. E - the scheme of constantly running CW: a - the upper water level to turn the tap d "off"; b - the bottom level of water to turn the tap d "on"; c - the "brain", analyzing the position of the float and directing the tap d through information flow f to open water flow e at the float position j and close it at the position I respectively; g - sink; n - CW; k - outgoing and m - incoming waterflow.**

The very schematic representation of the mentioned energy flow, which generates all in vivo through the balance of aerobic (AE) and anaerobic (AN) glycolysis, according to CAAEBC theory [12] could be represented by Coriolis whirlpool (CW) in the sink (Figure 1).

Let's just keep in mind that water flow represents the energy flow through dissipative structure [5-7,14-16]. Only the necessity to maintain the whirlpool structure requires regulating the flow through the tap d. What happened, if the tap is completely open, but the brain continues to receive messages from the float, that it is still in the very bottom position? In other words, what is missing on the Panel E of Figure 1, that exists in reality? It is emergency water supply that should maintain incoming waterflow m tense enough. The structure is shown on Figure 2. As an example of some inefficient and energy-consuming water sources, we choose the Archimedes screw in case of problems with regular tapping water. It is getting quite obvious that the description of even such simple system to repeat its behavior needs to take into account the endless number of the parameters. But if we need to describe the behavior of namely this system, we need only to perform a very bordered set of measurements to compile a set of parametrical equations that could predict the oscillations with desired precision, until changing the rules.

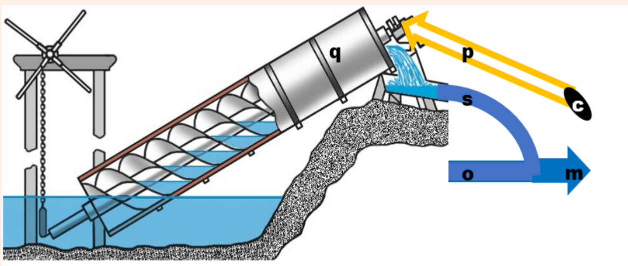

Figure 2 (continues from Figure 1): The modeling of AN compensation reaction for the living organism energy flow through emergency water supply connected to Archimedes screw. When the "brain" c realizes, that the maximal level of the incoming waterflow m doesn't allow the float to lift from position j, it sends the message p to the driving construction to the Archimedes screw q to initiate extra flow s, that should, combining with the general flow o, keep m on the desired level. From the view of AE-AN balance, it means the AN is now on until the signal p is terminated.

There are some successful applications of these ideas to biodegradation, but it needs to be developed further [17-19] to find the set of mathematical tools for the chosen levels of description.

Conclusion

We demonstrated that recent reports on in vivo biodegradation are quite far from simple hyperbolic shape. In this case it is necessary to employ the TIP and take into account possible oscillations if the process becomes associated with intrinsic energy flows. This approach allows to avoid the consideration of these processes as smooth asymptotic decay and find some hidden mechanisms.

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