THE MATRIX OF LIFE FOR EXOPLANETS. G. P. Słowik1 and P. Dąbrowski2, 1Department of Anatomy and Histology, Collegium Medicum, University of Zielona Gora, Zyty 28, 65-046 Zielona Gora, Poland, (grzegslowik@o2.pl), 2Division of Normal Anatomy, Department of Human Morphology and Embryology, Wroclaw Medical University, Chalubinskiego 6a, 56-368, Wroclaw, Poland, (pawel.dabrowski@umed.wroc.pl)

Introduction: In order to determine the universal biomarkers of microbiological life in exoplanet biotopes, it is essential from the theoretical and empirical perspective to construct the so-called multi-division matrix of life (ML), containing quantified data on variability of environmental conditions. The ML is to inform about the peripheral adaptation possibilities of unicellular organisms known from terrestrial ecosystems, such as extremophilic bacteria and/or archaea-microorganisms discovered in 1977 [1] by molecular biologists Carl Woese and George Fox [2] and constituting an ingredient of the so-called third domain of life on Earth. Archeons differ from both prokaryotic and eukaryotic organisms. They live in the vicinity of hot hydrothermal chimneys located in the ocean rift zone at the depth of nearly 4000 m, hot volcanic springs on the Earth's surface, highly saline places, as well as the coldest Earth's polar zones. Because of their adaptability and survival skills in extremely adverse environments, they constitute a group of archetypal (model) organisms, which are theoretically capable of surviving on exoplanets. Until recently, extraterrestrial research focused on the detection of water as a universal solvent that is involved in all metabolic processes. Currently, the role of methane is emphasized (next to oxygen, which is one of the “canonical” biomarkers [3] on modern Earth) as an indicator of life, available not only as a result of geological processes (e.g., serpentineisation). Methane can be produced on a global scale by anaerobic microorganisms (methanogenic organisms), which include representatives of, for example, Methanosarcina genus, that has several species producing methane by three different metabolic pathways [4]. Therefore, objective assessment of survival skills, manifested in metabolic capacity, and the ability to transfer genetic information of microorganisms that are analogues of terrestrial unicellular forms requires the definition of variable chemical and biological parameters in the ML. The ML is a theoretical model of survival conditions correlated with forms of microorganisms that can theoretically show adaptive abilities in selected ecosystems of both researched exoplanets and their natural satellites.

The matrix of life and Scale of life: Below are selected elements of the ML, taking into account a group of local astrophysico-chemical, environmental (including climatic and hydrological) and geological factors characterizing a given exoplanet:

1. Astrophysical:
- distance from the mother star
- existence of a magnetosphere
- type of orbit
- speed of the exoplanet rotation around its axis
- presence of a planetary system
- diameter and mass of the exoplanet
- temperature (of the surface, water reservoirs and atmosphere)
- pressure (both in water reservoirs and atmosphere)
- presence of condensation centers in the atmosphere of the exoplanet
- presence of free electric current carriers in the atmosphere

2. Chemical:
- composition of gases forming the exoplanet atmosphere (the presence of CO2, CO, O2, O, CH4, N2)
- degree of acidity of the atmosphere and/or soil (pH value)
- salinity
- presence of Fe, S, P

3. Environmental
(including climatic and hydrological):
- presence of water on the exoplanet (in different states of matter: solid, liquid or gas)
- glaciation
- geysers

4. Geological:
- type of the exoplanet surface
- geological activity of the planet's interior
- plate tectonics and rock-forming phenomena
- volcanism

Each element of the a Fallon matrix of the life is assigned a statistical weight \(w_{\text{env}}\), which reflects the contribution of this element to the whole of the considered features of this matrix. The ML is important information about the astrobiological condition of a given exoplanet, and its reflection is a calculated value of the matrix of life determinant (so-called “determinant of life” – DL) (for each correlation of ML variables). The values of these determinants will work in a stochastic and at the same time objective manner determine the possibilities of the emergence, proliferation and survival of life in the environment of a given exoplanet or its moon. As a result of grouping the values of determinants specified for each of the ML, one can obtain their natural gradient, which is a universal scale of life (SL).
Transferring life and potential terrestrial analogues of extraterrestrial life:

In consideration of the development of life on exoplanets and their natural satellites, attention should be paid to the possibility of “transferring” microbiological life between them. This possibility is provided by food chain substrates available in meteorites. A candidate among terrestrial analogues of extraterrestrial life, especially life in the clouds of Venus, able to survive on this type of cosmic objects, seems to be a microorganism whose terrestrial counterpart is the extremophilic bacterium - Acidithiobacillus ferrooxidans [5, 6]. The proposed mathematical models for the assessment of conditions for extraterrestrial life in the form of ML and SL will allow for better assessment and selection of future goals in the search for traces of life in the Universe.

References: