

Liberal Arts I (Cosmos and Life)

**MODULE HANDBOOK**

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Term: Fall Semester

Numbering NLA301

Credits 2

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This handbook provides information about the module and its operation. Please study it carefully.

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## 1. Introduction / Welcome

If we stand on the shore and look at the sea, we see the water, the waves breaking against rocks on the shore, the sound, the winds, and the sun shining in the blue sky. There are small fish and crabs, seaweed, hunger and disease, and sometimes even happiness and disappointment. All these including the observers ourselves, are constituents of our world, Cosmos. Phenomena going on there look all complicated, but we human beings in the present day are better and better acknowledging that they are understandable based on a small number of simple, beautiful laws and principles. In turn, when you look into your hands, you may become curious how fingers move as you want them to move. When you sing, you don't have to think about how your voices are made. But all these behaviors of humans are just examples of activities of Life. Life has evolved from its origin for four billion years of history on our planet. Principles of life should obey basic principles of physics, but there still remains an enormous amount of mystery. The module "Cosmos and Life" will provide you an opportunity to learn about basic ideas and concepts in modern science, particularly modern physics and biology.

## 2.0. Module Description

After drawing a rough sketch of our Cosmos and of its evolution, the first half of the course starts by discussing physics laws ruling our daily life, and then proceeds to quantum phenomena in the micro-scaled world, up to relativity governing the large-scale world, Cosmos. In the latter half, students learn "what Life is" from the viewpoint of biology. Topics include the origin of life and evolution, the hierarchy of life: genes - organelles - cells - tissues - organs - organisms - ecosystem, the energetics in life, the lives on the earth, and humans and brains.

### 2.1 Overall module aims:

The basic ideas and concepts in contemporary physics and biology will be presented. The overall aims of this module are to assist you to learn the way of scientific thinking, to get familiar with fundamentals in physics and biology, and thus to acquire sensibility to richness and wonders of Cosmos and Life.

### 2.2 Subject specific module aims:

The module is intended to assist you to assimilate and become able to use basic concepts and principles underlying the following subjects:

- classical mechanics; Newton's laws of motion and Galilei principle,
- special relativity; Lorentz's time dilation and length contraction,

- introductory general relativity; equivalence principle and curved space-time
- electromagnetism and electromagnetic waves, and
- introductory quantum mechanics,

and in the latter half, on

- what is life?
- evolution of life,
- hierarchy of life,
- energetics in life,
- the lives on the earth, and
- humans and brains.

### **2.3 Skills and abilities**

The module expects you to acquire the following skills/abilities:

- to perceive and analyse in a scientific way phenomena occurring in daily life and nature,
- to be open and kept acquainted with latest findings in science and technology, and
- to use and expand your scientific basis of knowledge in developing your activities in music and other professional scenes.

### **2.4 Applied learning**

The module also expects you:

- to take advantage of your scientific expertise to stimulate and enrich your music sensibility, and
- to build your basis of scientific knowledge that enriches your intellectual/artistic exchanges with people in the international community.

## **3.0. Learning Outcomes**

### **3.1. Learning outcomes – overall**

Students who successfully complete this module will have:

- acquired ability to perceive/analyse phenomena occurring in daily life and in nature in a scientific way,
- learnt the way of scientific thinking,
- been acquainted with fundamentals in physics and biology,

### 3.2. Learning outcomes - Specific

Students who successfully complete this module will have been acquainted with:

- laws governing the motion of an object in classical mechanics,
- important modifications in laws of motion that arise from special relativity,
- equivalence principle and relevance of the curved space-time in general relativity,
- electromagnetic interaction and occurrence of electromagnetic waves,
- particle-wave nature of physical existences, methods to analyse quantum phenomena in microscopic world,

## 4.0 The Module Team

The address for the Department within which your module is situated is:

Tokyo College of Music  
1-9 Kamimeguro,  
Meguroku, Tokyo

Staff involved in the organisation and delivery of this module are as follows:

<i>Koichiro Asahi</i>	<i>Module Leader</i>	<i>asahi@riken.jp</i>
<i>Akihiko Nakano</i>		<i>nakano@riken.jp</i>

### Module Leader

The Module tutor has the overall responsibility for organising, delivering and assessing a module. It is the Module Leader who you should see with any queries or problems related to a specific module, if the Course administrative officer cannot help.

<i>Nahoko Sakiya</i>	<i>Course administrator</i>	<i>ESC-office</i>	<i>nahoko_sakiya@tokyo-ondai.ac.jp</i>
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### Course administrator

The Course Assistant has responsibility for providing a full and responsive administrative service in support of the processes and procedures associated with student and course administration.

## 5.0 Indicative Syllabus

In a series of fifteen class sessions conducted under this module, each of the two module leaders in rotation will make presentation and lead discussion on the individual topics in physics and biology, which are detailed in Section 6.0 Delivery Information.

## 6.0. Delivery Information:

Week	Title	Synopsis
1	Overview of Cosmos: expanding universe and its origin	Outline of the module is given in the beginning. Then, the structure of our universe at the present era, its origin, evolution and future is discussed.
2	Classical laws of motion	Inertial property of an object, Newton's laws of motion, invariance under Galilei transformation of coordinates,
3	Special relativity	Michelson-Morley's experiment and invariance of the light speed, Lorentz transformation, time dilation and Lorentz contraction, twin's paradox
4	Curved space-time	Equivalence principle, acceleration and curvature of space-time, Einstein equation, expansion of universe
5	Electromagnetism	Fields and local interactions, electric and magnetic fields, Maxwell's equations, and electromagnetic waves
6	Introduction to quantum mechanics	Planck's light quanta, Bohr's condition, particle-wave nature of existences, Schroedinger equation, probability interpretation of wavefunction.
7	Microscopic world: atoms, nuclei, quarks and leptons	Structure of atoms and molecules, fermions and bosons, elementary particles, the standard model.
8	Symmetries in science	Invariances under parity transformation, time reversal, particle-antiparticle transformation, gauge transformation.
9	Origin and evolution of life	Introduction of biology: "What is life?" The birth of life on the earth and its evolution

		over 4 billion years.
10	Genes and genomes	The genome is the blueprint of life, in which dozens of genes are contained. Most of genes encode proteins, which are actual players of life.
11	Cells as the smallest units of life	There is a hierarchy in life: cells represent the smallest units of life, in which a variety of compartments (organelles) exist to fulfill activities of life.
12	From cells to organisms	Cells form tissues, tissues assemble in organs and organs make organisms. It is architecture of life.
13	Energetics in life	For the lives to be alive, energy is necessary. Solar energy is absorbed by plants, which then provide carbon sources available for animals.
14	Lives on the earth	A huge variety of organisms are living on the earth to form an ecosystem. Sustainable coexistence must be sought.
15	Humans and brains	Humans have acquired great abilities of living, which is largely due to the development of the supreme central nerve system, brains.

## 7.0 Independent Study – Preparation for Lecture

Before each class session, you are expected to read or check articles in books or Web pages, on the subjects that are going to be taken up in the session. In the end of the session you are required to answer several questions posed on the subjects and to submit a report concerning what you learned in the session as well as your answers to the questions.

## 8.0 Assessment and Practical Tasks:

### **Assignment:**

You are assigned a report at the end of each class session, as stated above in Sect. 7.0.

Your grade of achievement is assessed based on the report assignment (60 %) and contribution in class (40 %)

<b>Module Grading Bands</b>		
A+	90% +	<p>Excellent demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Well structured assignments that address the learning outcomes and specific criteria for the module.</li> <li>• Critical understanding is evident through systematic and relevant coverage of content.</li> <li>• Clearly communicated in a style appropriate to the assessment brief.</li> </ul>
A	80-89%	<p>Very good demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Well structured assignments that address the learning outcomes and specific criteria for the module.</li> <li>• Critical understanding is generally evident in the coverage of content.</li> <li>• Clearly communicated in a style appropriate to the assessment brief.</li> </ul>
B	70-79%	<p>Good demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Fairly well structured assignments that address the learning outcomes and specific criteria for the module.</li> <li>• Some critical understanding is evident through coverage of content which is also descriptive.</li> <li>• Good communication in a style appropriate to the assessment brief.</li> </ul>
C	60-69%	<p>Adequate demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Adequately structured assignments that address the learning outcomes and specific criteria for the module.</li> <li>• Largely descriptive with some critical understanding is evident through coverage of content.</li> <li>• Communicated in a style appropriate to the assessment brief.</li> </ul>
F Fail	40-59%	<p>Limited demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Poorly structured assignments that do not completely address the</li> </ul>



		<p>module learning outcomes and specific criteria.</p> <ul style="list-style-type: none"> <li>• Work is descriptive in its coverage of content.</li> <li>• Poor communication that does not use a style appropriate to the assessment brief.</li> </ul>
F Fail	10-39%	<p>Poor demonstration of scholarly application/critical understanding of subject area knowledge.</p> <ul style="list-style-type: none"> <li>• Poorly structured assignments that do not address the learning outcomes and specific criteria for the module.</li> <li>• Coverage of the content is inadequate or incomplete.</li> <li>• Poor communication that does not use a style appropriate to the assessment brief.</li> </ul>
F Fail	0-9%	<p>Very poorly structured assignments that do not address any of the learning outcomes or the specific criteria for the module.</p>

## 9.0 Further Reading Sources

### Books

- Steven Weinberg, "The first three minute" (Basic Books, 1993).
- Richard P. Feynman, "Six easy pieces" (Addison Wesley Publ. Co., 1994).
- Brian Greene, "The fabric of the cosmos: space, time, and the texture of reality" (Penguin Books. 2005).
- Kenneth S. Krane, "Modern Physics", (Wiley, 2012).
- Erwin Schrödinger, "What is life?" (Cambridge University Press, 1944) (reprinted, Canto Classics Edition, 2012)
- Eric J. Simon et al., "Campbell Essential Biology, 7<sup>th</sup> Edition" (Pearson, 2018)
- Bruce Alberts et al., "Essential Cell Biology, 5<sup>th</sup> Edition" (W W Norton & Co Inc., 2018)