[Reference Only]

Annex 10

The Requirements of Basic Academic Attainments for Senior Secondary Natural Science

I. Basic rationale

Natural Science is the general term for various disciplines studying the natural world, covering both the knowledge of the rich and colourful physical world and the exploration of vibrant plants, animals and humans themselves. In the long history, scientists established not only a huge body of knowledge, but also a unique approach to comprehend the world, giving birth to the scientific spirit, ethics and worldview. In modern society, natural science has penetrated into every aspect of our lives, becoming an extremely crucial and influential factor for social development. Through learning Natural Science at senior secondary education level, students should have a deeper understanding of science and further enrich their knowledge of scientific methods, scientific spirit and the relationship between science and society, so as to enhance their scientific literacy and lay a solid foundation for the present and future social life or academic development. On these grounds, the Requirements of Basic Academic Attainments for Junior Secondary Natural Science shall comply with the following fundamental principles:

(1) Aiming at promoting students' overall development, enabling the improvement of every student's level of scientific literacy.

Senior secondary education should further improve every student's science learning, in order to acquire the necessary scientific literacy for adapting to modern life and the future social development. In order to achieve the goal of enhancing students' scientific literacy, the science curriculum needs to pay more attention to students' differences in learning ability and take into account the particularity of students in terms of learning style, learning interests, knowledge and experience.

(2) Strengthening the connections between different disciplines, helping students understand the relationship between science technology and society.

Though natural science contains different contents, these contents are indeed closely linked with each other in terms of knowledge itself, as well as methods and values. Science, as a whole, also has connections and interactions with technology and society. Through the history of scientific development and the practice of modern

science, students need to further understand some common features of natural science, the dialectical relationship between science and technology, the positive impact of technology development on human society, and the negative issues caused by misuse of science and technology, so as to raise their awareness towards the nature of science.

(3) Laying stress on the diversification of teaching methods, and actively promoting inquiry learning

Scientific inquiry is a key feature of natural science, which is also an effective way to learn science. By conducting studies and surveys on open questions, students not only can acquire scientific knowledge, but also learn different scientific methods, develop thinking skills and scientific spirit. As senior secondary school students have already accumulated some knowledge and skills, therefore the science curriculum should provide more opportunities for students to conduct independent exploration. A variety of teaching methods should also be flexibly used according to the teaching objectives, teaching content and teaching resources during science teaching, so as to guide students to actively participate in the learning process.

II. Curriculum Goals

(1) Enable students to master some basic scientific methods and skills, and be able to solve some practical problems related to science.
(2) Guide students to understand the meaning and the basic process of scientific inquiry, and develop certain investigative skills.
(3) Help students develop rational, truth-seeking, open, and innovative scientific spirit.
(4) Guide students to understand the relationship between science, technology, society and the environment, and learn to approach and analyse social issues related to science.
(5) Lead students to understand the humanistic aspect of science, experience the close relationship between science and human progress and social development, as well as enhance the understanding of the nature of science.

III. The Requirements of Basic Academic Attainments in different learning domains

Explanation of coding:

(1) The capital English letters represent the requirements of basic academic attainments in different learning domains; A – “Scientific inquiry”, B – “History

of science and the nature of science", C – "Environment and resources", D – "Modern technology".

(2) The number following the English letter represents the serial number of the requirements of basic academic attainments in the respective learning domain.

Learning domain A - Scientific inquiry

A-1 Comprehend that inquiry is one of the essential properties of natural science, it is also a way of survival and life attitude.

A-2 Understand the importance of critical thinking in processing evidence, including the significant role of evidence in supporting, amending or refuting the proposed scientific theory.

A-3 Preliminarily learn to raise appropriate scientific problems and social science issues and identify the crux of the problem.

A-4 Preliminarily know how to use facts, experience or scientific theories to carry out logical reasoning and propose hypotheses.

A-5 Try to use critical thinking to present creative ideas and practical solutions to problems.

A-6 Search the scientific information needed through different means including library, the Internet, and multimedia resource database etc., and preliminarily learn to classify and summarise the information.

A-7 Try to assess the quality of the obtained information and observe the results, and discern the factors influencing the quality and reliability.

A-8 Preliminarily know how to deduce correct conclusions with direct evidence and circumstantial evidence.

A-9 Preliminarily know how to display research results with charts and write research reports with scientific terminology.

A-10 Be able to learn to complete a certain scientific inquiry research through group work, and know the importance of division of labour and cooperation in research.

Learning domain B - History of science and the nature of science

B-1 Preliminarily understand the difference and connection between science and technology.

B-2 Preliminarily know that science is a part of social and cultural tradition and scientific concepts are affected by the social and historical background.

B-3 By knowing the history of scientific development, understand the evolution

and revolution of science.

B-4 From the history of the discovery of the periodic table of the elements, preliminarily understand the conviction of scientists that the world is knowable and the impact of their conviction on scientific research.

B-5 From the history of the discovery of the benzene ring structure, understand the important role of creativity and imagination in scientific development.

B-6 From the history of the discovery of the atomic structure models, know the values and limitations of model construction in scientific inquiry.

B-7 Understand Galileo and Newton's contributions to science and the importance of their experimental methods in scientific development.

B-8 Realise that theory or law has different roles in science by understanding the history of western science about knowing the nature of light.

B-9 Preliminarily understand the process of human cognition of electromagnetic interaction and its impact on human society.

B-10 Be able to analyse and explain the establishment process of cell theory, and understand the main features of scientific discovery.

B-11 Be able to analyse and explain the human exploration process of genetic material, and understand the important role of experimental techniques in scientific research.

B-12 Be able to briefly describe the formation and development of biological evolutionary thought, and realise the relationship between scientific development and society, culture, religion and the like.

B-13 Know about the development of modern astronomy and earth sciences, and explain its significance to the progress of human civilisation.

Learning domain C - Environment and resources

C-1 Understand common non-metallic compounds including chlorine, nitrogen, sulfur, silicon, etc., as well as the impact of recycling of common metals on the ecological environment.

C-2 Understand the main components of home decorating materials and their effects on human health.

C-3 Know the situation of light pollution, white pollution, electromagnetic pollution and other environmental pollution in Macau as well as the hazards caused by them.

C-4 Understand the application of nuclear energy and the essentiality and methods of properly handling the radioactive waste from nuclear power plant.

C-5 Understand the impact of land reclamation on the ecological environment.

C-6 Be able to discuss the balanced relationship between urbanisation, industrialisation and environmental preservation.

C-7 Be able to discuss the formation and significance of biodiversity.

C-8 Be able to analyse and illustrate the energy flow and material cycle of ecosystems, and explore the practical application of these laws.

C-9 Be able to explore the global environmental problems and the protection measures, and pay attention to the current situation of the ecological environment in Macao.

Learning domain D - Modern technology

D-1 Know the important role of the derivatives of ethylene, vinyl chloride, and benzene etc. in chemical production, be able to illustrate with examples the application of macromolecular materials in life and other areas.

D-2 Preliminarily understand the detection methods for the composition and structure of common substances, know the roles of mass spectrometer, nuclear magnetic resonance instrument (NMR instrument), infrared spectrometer and other modern instruments in detecting the structure of substances.

D-3 Preliminarily understand the principle of the operation of laser and optical fibers and their application in production and life.

D-4 Understand the role of science and technology in promoting human society through the knowledge of microscopes, telescopes and X- ray diffraction, etc.

D-5 Be able to illustrate the application of satellite technology in life.

D-6 Understand the microstructure of liquid-crystal, and know the main differences between high definition television (HDTV) and cathode ray tube television (CRT television).

D-7 Understand the impact of telecommunication equipment and network technology on human economic and social development.

D-8 Be able to pay attention to the genome-related information and genetic diagnosis and treatment, understand the meaning of the human genome project, and exemplify the impact of genetic engineering on production and life.

D-9 Collect the information about the development progress of stem cell research and the application of stem cells, and understand the significance of stem cell research for human beings.

D-10 Pay attention to the development of cloning and organ transplant technology as well as the possible social and ethical issues.