Today, July 24, 2022, the Wentian module of the China space station (CSS) has been successfully launched into orbit. In a few days, it will dock with the Tianhe core module, which was previously launched last year in April. The third experiment module, Mengtian, is scheduled to go into orbit later this year. At that time, the CSS will look like the diagram shown in Figure 1.

The length of the Wentian module is 17.9 m (equivalent to the height of a six-story building). It is 1.3 m longer than the Tianhe core module. The Wentian module will support more science and applications than the Tianhe core does, with plenty of internal and external research resources.

The module includes two scientific racks, which are called the life and ecology research rack (LER) and the biotechnology experiment rack (BTR). In addition, there are two supporting racks, which include the glovebox and cold storage rack and the variable gravity research rack (VGR). They were launched simultaneously within the Wentian module. On the exterior of the Wentian module, more than 20 payload adapters and one large payload hanging site provide standard mechanical, thermal, electrical, and data interfaces for the exposed payloads. Two external facilities, including a materials exposure experiment device and a universal exposure device for components and parts, were developed, launched in the later Tianzhou cargo mission, and installed in the Wentian module’s external payload adapters.

The experiment racks in the pressurized sections and exposed facilities are as follows:

- **The LER consists of a general-creature cultivation system, a small centrifuge, a microbe detection unit, a small controlled-life ecological experiment unit, and a small-general-creature cultivation unit. The LER supports research on the microgravity and space radiation effect on the growth, development, and aging of living organisms (including plants and animals) and explores space radiation biology. In addition, it can be used to study the fundamental problems of closed ecological systems, and it houses complex cultivation experiments and technologies on small organisms.

- **The BTR consists of a cell and a tissue experiment system, a cell and tissue detection and regulation unit, and a protein crystallization and analysis unit. BTR supports cell cultivation and tissue construction with tissues, cells, biochemical molecules, and other biological samples. In addition, it can be used in space biotechnology and applied research such as molecular bio-manufacturing technology, space protein crystallization and analysis, the origin of life, and space biomechanics. The research is expected to make breakthroughs in innovative biomaterials, medicines, and medical technologies and will actively guide and promote agriculture and pharmaceutical and environmental biotechnology research and development on Earth.

- **The glovebox and cold storage rack consists of a scientific glove box and cryogenic storage apparatus. The glovebox (located in the upper part of the rack) can provide a closed and clean environment with controllable temperature and humidity. It can support a delicate operation needed for life science and other scientific experiments. Samples can be prepared by a built-in mechanical arm and viewed with...
a microscopy device. For long-term experiments, the cryogenic storage device (located in the lower part of the rack) can provide low-temperature storage at 4°C, −20°C, or −80°C for long-term experiments.

- The VGR consists of two rotor centrifuges, a monitoring system, a lighting system, and a stator controller. The chief function of the VGR is to provide on-orbit variable gravity levels in the range from 0.01 to 2 g. This module can simulate different gravity environments for fluid, life, and materials sciences.

- Two exposed facilities for materials and components have been developed. The materials exposure experiment device supports the study of various functional materials such as aerospace metals, inorganic non-metals, and polymers. It can study the spatial operation and performance of materials in space subjected to atomic oxygen ablation, high-energy particle radiation, alternating hot and cold environments, and ultra-high vacuum. These experiments will provide reference data for developing and applying new space materials. The universal exposure devices for components and parts supports the on-orbit testing for integrated circuits, discrete semiconductor devices, optoelectronic devices, and other elements that are sensitive to the space environment, and it obtains the parameters of devices under the stress of space. It allows for studying these objects’ reliability and promotes the development of new components.

After completing the on-orbit tests, the experiment racks and exposed facilities will be used to conduct scientific research or applications. Twenty-four scientific projects (including four international projects) have been deployed in the internal racks of the Wentian module. Twenty-one projects are for space life science, and the other three explore microgravity physics. These projects use samples such as rice, animal bone cells, myoblasts, nematodes, zebrafish, algae, fruit flies, protein, and nucleotides. It is anticipated that they will obtain the response mechanism of different organisms and various levels of life samples under a space environment, reveal the carcinogenic mechanism of space radiation, and discover the molecular mechanism involved in radiation damage and repair. Projects in microgravity physical sciences are dedicated to understanding the laws of flow and heat transfer under boiling, exploring the behavior and movement law of a gas/liquid two-phase fluid, and studying the rheological law of steady-state particle flow under gravity. Scientists can now apply for new research opportunities based on pre-results, scientific, or objective requirements.

The CSS is scheduled to run for more than 10 years. It will support large-scale space science research and other science applications. The investigations on the Wentian experiment module will primarily focus on space life sciences. Its objectives are as follows:

1) Studying the influence of the space environment (e.g., microgravity, hydromagnetic field environment, and radiation) on organisms from molecules to tissues, organs, and individuals and exploring the laws of space growth and breeding on living bodies.

2) Revealing the system development and evolution law of multi-generation replacement of organisms to provide theoretical and technical support for constructing closed-loop ecosystems.

3) Exploring the formation mechanism, the occurrence, and the evolution conditions of primitive cells in a unique space environment.

4) Developing novel medical technologies and products, e.g., stem cells and regenerative medicines and synthetic bio-manufacturing, to improve medical and health services.

During the operation of the CSS, research projects will be continually added. Scientists throughout the world are welcome to propose new experiments. Chinese scientists are also encouraged to collaborate on these projects.

REFERENCES

1. China Manned Space Agency (2019). Scientific Experiment Resource Manual of China’s Space Station (China Manned Space). http://www.cmse.gov.cn/art/2019/4/23/art_810_33072.html.

2. Gu, Y., Gao, M., and Zhao, G. (2020). Science research and utilization planning of China’s Space Station in operation period 2022-2032. Chin. J. Space Sci. 40, 609–614.

3. Zhao, W. (2021). Scientific aspirations of the Chinese Space Station program: an interview with. Natl. Sci. Rev. 8, nwab161.

4. Gu, Y. (2022). The China Space Station: a new opportunity for space science. Natl. Sci. Rev. 9, nwab219.

DECLARATION OF INTERESTS

The authors declare no competing interests.