3 - 80 Heavy-ion Irradiation Drug Development in Retrospect and Prospect

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The world is facing severe challenges of sustainable development, which requires the joint effort of the global science community to solve. As China continues to grow at a very impressive pace, the state appears acutely aware of the need to expand the Chinese science and technology portfolio to help fuel its growth and keep it sustainable. China also needs to continue on the path to innovations and modernization, focusing on endogenous growth to realize full, coordinated, and sustainable development.

In terms of pharmaceuticals, the world's pharmaceutical industry is facing the shrink of new drug R & D investment, reduction of the number of new product approval and listed and patent expiration, and the drug production patterns are changing. After years of development, China has a very good accumulation on the drug production. Facing the opportunities for change, how to use and play our advantage, breaking the barriers of large foreign pharmaceutical companies, become the key to the future development of China's pharmaceutical industry. Heavy ion irradiation drug production as a new method plays an important role both in the discovery of the structure of new drugs, high-quality traditional Chinese medicine.

In order to meet the national strategic demands and keep abreast of global advances in science and technology, the mission of Heavy-ion research in drug molecule, Chinese herbal medicine and microbes resources is to carry out strategic, innovative, and forward-looking studies, promote breakthroughs in key technologies and integrated innovation, provide systematic solutions.

In terms of Quinoxaline compounds, using the heavy-ion irradiation induced mutation, by applying different dosages and heavy-ions to Quinoxaline compounds, the research aims on screening the irradiation induced novel structural compounds through methods of segregation and structural and identification for developing new veterinary drugs. The research also offers technological supports on the forecast of the heavy-ion irradiated pharmic molecule modification and the irradiation and screening of lead compounds. Therefore, it establishes the foundation of expending a new method of developing novel drugs. Moreover, the research discusses the mechanism between heavy-ions and drugs molecular mass, the energy deposition and the charge exchange effect at the molecular level.

In terms of Chinese herbal breeding, however, both the output of Isatis indigotica and the level of its active ingredients vary greatly according to different varieties of the plant and the atmospheric conditions under which it is produced, so its quality can be unstable. Traditional hybridization based breeding is inefficient because of the lack of genetic resources and a long breeding cycle. Therefore, we chose new techniques to produce novel varieties to provide quality raw materials. The use of Heavy-ion irradiation is an effective method to generate plant mutants. The aim of this study is to investigate the effects of different doses of 100 MeV/u carbon ions on *Isatis indigotica* seeds in order to improve crop yields and their active ingredients content.

Currently, there is the Heavy-ion irradiation drug development following outstanding issues: (1) our research team is still working on the systematic study of heavy-ion irradiation modifiction on Quinoxaline compounds. The optimal parameters of the irradiating ion needs to be optimized. The mechanism of heavy-ion induced structural modifiction needs to be explored and proofed. The universality of this method needs much more experimental analysis, as a consequence the research will provide a methodological direction for heavy-ion induced structural modifiction on other drugs; (2) Exploring effective and efficient methods to induce mutations is an important and challenging task, With the development of high-throughput sequencing technologies, it has become possible to estimate the rate of spontaneous mutations. The advent of plant genomics and high throughput DNA techniques, have opened a new era of molecular mutation breeding. Further work will focus on the isolation of the related genes that control the mutant phenotypes. Studies in gene function, interaction effects, and signal pathways will be launched in the near future in order to clarify the molecular mechanism of mutagenesis induced by ion beams.

Going forward, we are convinced that the Heavy-ion irradiation drug development will play a key role for communicating such interdisciplinary research, as well as relevant results in the constituent areas of particle physics and nuclear physics, biochemistry, molecular biology, genomics, applied microbiology, cellular nutrition in health and disease, cellular physiology, and biochemical engineering.