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A New Chapter in the Antitumor Effects of Chinese Herbal Protein Peptides

The ancient legend of “Shen Nong tasting hundreds of herbs” ushered in millennia of wisdom in utilizing natural medicines to treat diseases among the Chinese nation. Within the voluminous texts of traditional Chinese medicine, countless herbs are documented for their efficacy in “dissolving masses and dispersing nodules” and “breaking up blood stasis and expelling stagnation”—concepts that align remarkably with modern medicine's anti-tumor principles. Yet what “sword” lies hidden within these plant bodies to strike directly at the cancer demon? Modern science has turned its gaze to a class of subtle yet potent substances—proteins and peptides. Today, we lift this veil of mystery to see how ancient wisdom, empowered by modern technology, forges new weapons against tumors.

I. Natural Proteins and Peptides in Traditional Chinese Medicine

Among numerous traditional Chinese medicines with anti-tumor potential, scientists have discovered a series of active proteins and peptides through meticulous exploration. Though not massive in size, these

compounds often exert a disproportionately powerful effect, disrupting the vital functions of tumors. For instance, Trichosanthes protein, extracted from the cucurbitaceous plant *Trichosanthes kirilowii*, is hailed as a “natural Trojan horse.” It cleverly infiltrates tumor cells, subsequently inhibiting ribosomal function and blocking protein synthesis, ultimately starving cancer cells to death. Similarly, momordicin, isolated from bitter melon seeds, has been proven to induce apoptosis in various cancer cells. Meanwhile, *Ganoderma lucidum* peptides—derived from this “mystical herb”—function more like an “immune commander.” Rather than directly killing cancer cells, they activate immune forces like macrophages and natural killer cells, enhancing the body's own surveillance and clearance capabilities to “cut off the tumor's lifeline.” Similarly, ginseng peptides have been found to regulate immunity and inhibit tumor angiogenesis.

Although these natural products are effective, their direct application often faces challenges: their content in traditional Chinese medicine is extremely low, making extraction and purification akin to finding gold in sand, with high costs; moreover, their complex structures are easily broken down by the gastrointestinal tract when taken orally. Like an unpolished sword, though made of rare materials, they struggle to unleash their full potential.

II. Peptide Synthesizer - Turning Stone into Gold

How can we overcome the challenges of natural extraction? How can we

optimize the structures of these bioactive peptides? This is where the “powerhouse” of modern biochemistry comes into play—the peptide synthesizer.

Imagine synthesizing a peptide is like stringing a necklace with amino acids as “beads” according to precise blueprints. The peptide synthesizer is the “deft hand” that automates this intricate task. Based on solid-phase synthesis principles, it anchors the first amino acid onto an insoluble resin. Then, following a predetermined sequence, it cyclically performs steps like deprotection, coupling, and washing to sequentially add amino acids, ultimately synthesizing the target peptide chain. The entire process is precisely controlled by computer, ensuring high efficiency and accuracy while enabling the synthesis of modified sequences not found in nature. This “technological needle” is crucial for research into antitumor peptides in traditional Chinese medicine:

1. Cloning Natural Essences: Once scientists decipher the amino acid sequence of an active peptide in traditional Chinese medicine, they can rapidly and mass-produce it in laboratories using synthetic instruments, thereby eliminating dependence on the original herbal materials.

2. Optimizing “Sword” Design: Natural peptides may be unstable or exhibit certain side effects. Using synthetic instruments, researchers can “engineer” them—for instance, by replacing specific amino acids, creating cyclic structures, or linking multiple active fragments in series—to develop

enhanced versions of antitumor peptides that are more potent, less toxic, and more stable.

3.Unraveling the Mechanism of Action: By systematically synthesizing and testing a series of structurally similar peptide analogues, we can precisely identify the key structural domains responsible for their antitumor activity—essentially pinpointing the “edge of the blade”—thereby guiding subsequent drug design efforts.

III.The Present and Future of Traditional Chinese Medicine Peptide Drug Development

Leveraging peptide synthesis technology, several peptide drugs inspired by traditional Chinese medicine have emerged or are under exploration. For instance, synthetic peptides designed to mimic the immunomodulatory functions of certain traditional Chinese medicine peptides have entered clinical trials as tumor vaccines or immune adjuvants. Other research combines TCM peptide fragments with tumor-targeting capabilities with chemotherapeutic drugs or toxins to create “biological missiles” for precision strikes.

Looking ahead, the future of this field holds even greater promise. With the integration of artificial intelligence and big data technologies, scientists can design peptide drugs more intelligently. Advances in peptide synthesizer technology have made it possible to synthesize more complex and longer peptides, and even proteins. Perhaps one day, we will design

“super peptides” that combine the essence of multiple traditional Chinese medicines, or develop “smart peptides” capable of intelligently releasing drugs in response to changes in the body's environment.

From the simple philosophies of the Yellow Emperor's Classic of Internal Medicine to peptide synthesizers in laboratories; from roots and bark in medicinal pots to precisely engineered anti-cancer stars—this millennia-spanning dialogue is far from over. Research on the anti-tumor properties of Chinese herbal proteins and peptides now stands at the intersection of traditional wisdom and modern technology. It reminds us that ancient treasures still hold countless unsolved codes, and the key to unlocking them lies in our ever-innovating technological “embroidery needles.” This represents not only pharmaceutical innovation but also a fusion of mindsets—using the most modern techniques to listen to the wisdom of the most ancient life forms, jointly forging new paths of hope in the battle against cancer, humanity's most stubborn disease.