

中药活性成分调控 $\gamma\delta$ T细胞抗肿瘤免疫功能的研究进展^Δ

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摘 要 $\gamma\delta$ T细胞兼具先天性与适应性免疫特征,其抗原识别不依赖经典的主要组织相容性复合体呈递,可直接识别肿瘤代谢异常,在免疫低浸润肿瘤中具有独特应用潜力。本文系统梳理 $\gamma\delta$ T细胞的生物学特性及其抗肿瘤免疫功能特点,重点综述中药活性成分调控 $\gamma\delta$ T细胞抗肿瘤免疫功能的相关机制,发现甘草多糖、黄芪多糖可通过促进多种细胞因子表达、调节肠道菌群、改善免疫抑制状态等,增强 $\gamma\delta$ T细胞的抗肿瘤免疫功能;槲皮素和葛根素可通过调节 $\gamma\delta$ T细胞的增殖、细胞毒效应分子表达及相关信号通路活性,增强 $\gamma\delta$ T细胞介导的肿瘤细胞杀伤作用;川楝素可通过下调肿瘤细胞中抗凋亡蛋白表达,增强 $\gamma\delta$ T细胞对肿瘤细胞的杀伤作用;青蒿琥酯可通过增强 $\gamma\delta$ T细胞效应功能并减弱肿瘤细胞免疫逃逸能力,促进 $\gamma\delta$ T细胞介导的抗肿瘤免疫效应。未来可重点探索中药活性成分与 $\gamma\delta$ T细胞免疫治疗联合应用的协同效应及相关分子机制,明确 $\gamma\delta$ T细胞发挥抗肿瘤免疫功能的关键靶点。

关键词 $\gamma\delta$ T细胞; 中药; 活性成分; 抗肿瘤; 免疫治疗; 免疫逃逸

Research progress on regulation of antitumor immune function of $\gamma\delta$ T cells by active ingredients of traditional Chinese medicine

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ABSTRACT $\gamma\delta$ T cells possess both innate and adaptive immune characteristics. Their antigen recognition is independent of major histocompatibility complex presentation, and they can directly recognize abnormal tumor metabolism, showing unique application potential in tumors with low immune infiltration. This paper systematically sorts out the biological characteristics and antitumor immune functions of $\gamma\delta$ T cells, and mainly reviews the relevant mechanisms by which active ingredients of traditional Chinese medicine regulate $\gamma\delta$ T cells to exert antitumor immune functions. *Glycyrrhiza* polysaccharide and *Astragalus* polysaccharide can enhance the antitumor immune function of $\gamma\delta$ T cells by promoting the expression of various cytokines, regulating intestinal flora and alleviating immunosuppressive state. Quercetin and puerarin can strengthen $\gamma\delta$ T cell-mediated tumor cell killing by regulating the proliferation of $\gamma\delta$ T cells, the expression of cytotoxic effector molecules and related signaling pathways. Toosendanin can potentiate $\gamma\delta$ T cell-induced tumor cell killing by down-regulating the expression of anti-apoptotic protein in tumor cells. Artesunate can boost $\gamma\delta$ T cell-mediated antitumor immune responses by enhancing the effector function

of $\gamma\delta$ T cells and weakening tumor immune escape. Future research shall focus on exploring the synergistic effects and molecular mechanisms of the combined application of active ingredients of traditional Chinese medicine and $\gamma\delta$ T cell immunotherapy, and identifying the key targets for $\gamma\delta$ T cells to exert antitumor immune functions.

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