



REVIEW

Exosomes for hair growth and regeneration

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Exosomes are lipid bilayer vesicles, 30–200nm in diameter, that are produced by cells and play essential roles in cell–cell communication. Exosomes have been studied in several medical fields including dermatology. Hair loss, a major disorder that affects people and sometimes causes mental stress, urgently requires more effective treatment. Because the growth and cycling of hair follicles are governed by interactions between hair follicle stem cells (HFSCs) and dermal papilla cells (DPCs), a better understanding of the mechanisms responsible for hair growth and cycling through exosomes may provide new insights into novel treatments for hair loss. In this review, we focused on the comprehensive knowledge and recent studies on exosomes in the field of hair development and regeneration. We classified exosomes of several cellular origins for the treatment of hair loss. Exosomes and their components, such as microRNAs, are promising drugs for effective hair loss treatment.

Section snippets

Exosomes and extracellular vesicles

Extracellular vesicles (EVs) are lipid bilayer vesicles, which can be secreted by most types of cells, including bacteria, fungi, plant cells, parasites, and animal cells, indicating a conservative evolution (7). EVs include exosomes, microvesicles and apoptotic bodies. In terms of size, the diameter of exosomes ranges from 30 to 200nm; the size of microvesicles is 100–1000nm; the largest is the apoptotic body, which has a diameter from 500 to 2000nm (8). The process of exosome formation is...

Isolation and characterization of exosomes

Currently, there are several exosome isolation methods, including ultracentrifugation, ultrafiltration, polymer precipitation, size-exclusion chromatography, immunoaffinity capture, and microfluidics-based techniques (11). According to a review (12) in which 126 articles were counted to analyze exosome isolation methods, ultracentrifugation is the most widely used method to isolate exosomes from the culture media of mesenchymal stem cells (MSCs), accounting for approximately 54%, followed by...

Hair follicle development as well as hair growth and maintenance

As shown in Fig.2A, a series of signals between epithelial and mesenchymal cells lead to changes in both cell populations that eventually differentiate into mature hair follicles. The crosstalk between the two cell types may be largely governed by exosome-mediated transport, which will be discussed later. The emergence of a first dermal signal in the dermis results in the formation of thickenings of some parts of the epidermis, called placodes. Signals from the epithelial cells of the placode...

Hair loss treatment in cell therapy and the use of exosomes

As early as 1997, transplanted cells (containing DPCs) could be used for hair regeneration in animal models for the treatment of hair loss (33). When freshly prepared hair buds or primary mouse keratinocytes were mixed with active rat DPCs and transplanted into nude mice, hair follicles formed in the reconstructed skin, whereas no hair follicles formed in the reconstructed skin when hair buds or keratinocytes were mixed with dermal fibroblasts. The hair-inducing activity of DPCs was retained;...

DPC-derived exosomes

In the current exosome studies in the field of hair, exosomes derived from DPCs are widely used in hair studies. DPCs are mesenchymal cells with adult stem cell properties that regulate hair follicle development by interacting with epithelial cells and play an essential role in the hair growth cycle (53).

In a study by Zhou et al. (46), human two dimensional cultured DPC-Exos were injected into the dorsal skin of mice in the telogen and anagen phases. The results showed that hair follicles...

Current limitation of exosomes in clinical applications

The use of exosomes in various medical fields has attracted increasing interest from researchers; however, there are still limitations to their clinical application. There is a lack of a uniform gold standard for the origin, isolation, purification, identification, and storage; furthermore, clinical applications require a high degree of controllability and standardization (67). The precise quantification of exosomes and effective concentration methods are also of interest because ensuring that...

Conclusion and perspectives

Exosomes have been widely studied owing to their long shelf life, simple storage conditions, long intracellular communication distances, and low risk of immune responses, making them superior to direct cell therapy (69). Here, we present the mechanisms and related studies of exosomes in the promotion of

hair growth and regeneration. Because of their paracrine role, exosomes are involved in a variety of physiological and pathological processes in hair follicles. As intercellular messengers,...

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References (69)

E. Chargaff *et al.*

[The biological significance of the thromboplastic protein of blood](#)

J. Biol. Chem. (1946)

M. Takagi *et al.*

[Polymer fraction including exosomes derived from Chinese hamster ovary cells promoted their growth during serum-free repeated batch culture](#)

J. Biosci. Bioeng. (2021)

H. Saito *et al.*

[Analysis of extracellular vesicles as a potential index for monitoring differentiation of neural lineage cells from induced pluripotent stem cells](#)

J. Biosci. Bioeng. (2021)

M.H. Hardy

[The secret life of the hair follicle](#)

Trends Genet. (1992)

S. Reddy *et al.*

[Characterization of Wnt gene expression in developing and postnatal hair follicles and identification of *Wnt5a* as a target of Sonic hedgehog in hair follicle morphogenesis](#)

Mech. Dev. (2001)

J. Huelsken *et al.*

[\$\beta\$ -Catenin controls hair follicle morphogenesis and stem cell differentiation in the skin](#)

Cell (2001)

M.J. Bitgood *et al.*

Hedgehog and Bmp genes are coexpressed at many diverse sites of cell-cell interaction in the mouse embryo

Dev. Biol. (1995)

Sarah E. Millar

Molecular mechanisms regulating hair follicle development

J. Invest. Dermatol. (2002)

J. Kamimura *et al.*

Primary mouse keratinocyte cultures contain hair follicle progenitor cells with multiple differentiation potential

J. Invest. Dermatol. (1997)

M. Yamane *et al.*

Effects of the PI3K/Akt signaling pathway on the hair inductivity of human dermal papilla cells in hair beads

J. Biosci. Bioeng. (2022)



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Cited by (0)



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