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Criteria to Distinguish Endogenous Telomerase-Positive Totipotent Stem Cells from Exosomes as Major Players in Regenerative Medicine

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Abstract

Endogenous adult-derived Totipotent Stem Cells (TSCs) and tissue-resident exosomes are major players in the field of regenerative medicine. TSCs provide the undifferentiated building blocks for tissue repair, while exosomes provide the directions on how these building blocks should be used to accomplish this feat, i.e., restoration of fully functional tissue. Both TSCs and exosomes have been extensively characterized with respect to composition and function. While they have similar characteristics in four categories, they differ with respect to each other in a myriad of other categories. The following is criteria used by this lab to distinguish telomerase-positive totipotent stem cells from bioactive factor-containing exosomes.

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Keywords

Totipotent Stem Cell; Exosomes; Regenerative Medicine; Trypan Blue

Opinion

Endogenous adult-derived telomerase-positive Totipotent Stem Cells (TSCs) and exosomes are major players in the field of regenerative medicine. TSCs have been extensively characterized with respect to size, composition, cell surface markers, cryopreservation conditions, gene expression, differentiation potential, and use in regenerative medicine [1-3]. Exosomes have been analyzed in a similar fashion [4-7].

Both TSCs and bioactive factor-containing exosomes can be found in either solid tissues or in cell culture medium. They can be isolated by high speed centrifugation. They exhibit positive staining with trypan blue, and have a size within the range of 0.1 to 2.0 microns. For additional comparisons, see Table 1.

	TSCs	Exosomes
Isolated from solid tissues	Yes	Yes
Isolated from cell culture medium	Yes	Yes
Isolation	High Speed Centrifugation	High Speed Centrifugation
Trypan blue staining	Positive	Positive
Size	0.1 to 2.0 microns	0.1 to 2.0 microns
Description	Plasma membrane bound heterochromatic nucleus	Plasma membrane bound bioactive factor(s)
Contain telomerase enzyme	Yes	No
Species-specific chromosomes	Yes	No
Karyotyped	Yes	No
CEA-CAM-1	Present	Absent
CD66e	Present	Absent
Increase in number	Equal cell division	Budding from existing cell
Proliferation Agents	No	Yes

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Progression agents	No	Yes
Inductive agents	No	Yes
Inhibitory agents	No	Yes
Freeze at -20°C	No	Yes
Freeze at -80°C	Yes	Yes
Use cryoprotectant	Yes	No
Freeze at -196°C	No	Yes
Expressed genes	Telomerase, Bcl-2, Nanog, Nanos, CXCR4	No
Differentiation Potential	Form all tissues of body, derived from ectoderm, mesoderm, endoderm, gametes, and notochord	Induce all tissues of body, derived from ectoderm, mesoderm, endoderm, gametes, and notochord
Treat Conditions	AD ¹ , ALS ² , B ³ , BMT ⁴ , CIDP ⁵ , CKD ⁶ , COPD ⁷ , CVD ⁸ , D ⁹ , Dia-I ¹⁰ , Ep ¹¹ , IPF ¹² , MD ¹³ , MI ¹⁴ , MS ¹⁵ , N ¹⁶ , OA ¹⁷ , OrD ¹⁸ , PD ¹⁹ , RA ²⁰ , Sc ²¹ , Sk ²² , SkR ²³ , SLE ²⁴ , TBI ²⁵ , TSCI ²⁶	

Table 1: Comparisons between TSCs and Exosomes. AD¹, Alzheimer's Dementia [1]; ALS², Amyotrophic Lateral Sclerosis [1]; B³, Blindness [1]; BMT⁴, Bone Marrow Transplant [4]; CIDP⁵, Chronic Inflammatory Demyelinating Polyneuropathy [1]; CKD⁶, Chronic Kidney Disease [1]; COPD⁷, Chronic Obstructive Pulmonary Disease [1,8,9]; CVD⁸, Cardiovascular Disease [1,10]; D⁹, Dementia [1]; Dia-I¹⁰, Diabetes mellitus type-I [1,11,12]; E¹¹, Epilepsy [1]; IPF¹², Interstitial Pulmonary Fibrosis [1,8,13]; MD¹³, Macular Degeneration [1]; MI¹⁴, Myocardial Infarction [1,4,14,15]; MS¹⁵, Multiple Sclerosis [1]; N¹⁶, Neuropathies [1]; OA¹⁷, Osteoarthritis [1,4]; OrD¹⁸, Orthopedic disorders [1,4]; PD¹⁹, Parkinson Disease [1,16-18]; RA²⁰, Rheumatoid Arthritis [1]; Sc²¹, Sciatica [1]; Sk²², Stroke [1]; SkR²³, Skeletal muscle repair [1,4]; SLE²⁴, Systemic Lupus Erythematosus [1,19]; TBI²⁵, Traumatic Brain Injury [1]; TSCI²⁶, Traumatic Spinal Cord Injury [1].

TSCs provide the undifferentiated building blocks for tissue repair, while exosomes provide the directions on how these building blocks should be used to accomplish this feat, i.e., restoration of fully functional tissue. As shown, both TSCs and exosomes are readily available

in the tissues of the body, can be isolated and have their own respective attributes that can be used in regenerative medicine to enhance the healing process and restore function to an organ [8-19].

Conclusion

Endogenous adult-derived totipotent stem cells and tissue-resident exosomes are major players in the field of regenerative medicine. TSCs provide the undifferentiated building blocks for tissue repair, while exosomes provide the directions on how these building blocks should be used to accomplish this feat, i.e., restoration of fully functional tissue. Both TSCs and exosomes have been extensively characterized with respect to composition and function. While they have similar characteristics in six categories, e.g., isolation from solid tissues, isolated from cell culture medium, centrifugation, trypan blue staining, size, and cryopreservation temperature, they differ with respect to each other in other categories, e.g., morphology, telomerase enzyme, species-specific number of chromosomes, karyotyped, cell surface staining for CEA-CAM-1 and CD66e, proliferate, contain bioactive factors for proliferation, progression, induction, inhibition, freeze at -20°C, freeze at -80°C, expressed genes, differentiation into all cells of the body, and various conditions treated. The above criteria are being used distinguish telomerase-positive totipotent stem cells from bioactive factor-containing exosomes for their use in regenerative medicine.

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