

# **Functional and Molecular Characterisation of Mesenchymal Stem Cells Derived From Bone Marrow and Dental Tissues**

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## 7. Bibliography

1. Thomson, J.A., Itskovitz-Eldor, J., Shapiro, S.S., Waknitz, M.A., Swiergiel, J.J., Marshall, V.S., and Jones, J.M., *Embryonic stem cell lines derived from human blastocysts*. Science 1998; 282(5391): 1145-7.
2. Evans, M.J. and Kaufman, M.H., *Establishment in culture of pluripotential cells from mouse embryos*. Nature 1981; 292(5819): 154-6.
3. Martin, G.R., *Isolation of a pluripotent cell line from early mouse embryos cultured in medium conditioned by teratocarcinoma stem cells*. Proc Natl Acad Sci U S A 1981; 78(12): 7634-8.
4. Takahashi, K. and Yamanaka, S., *Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors*. Cell 2006; 126(4): 663-76.
5. Takahashi, K., Tanabe, K., Ohnuki, M., Narita, M., Ichisaka, T., Tomoda, K., and Yamanaka, S., *Induction of pluripotent stem cells from adult human fibroblasts by defined factors*. Cell 2007; 131(5): 861-72.
6. Lenoir, N., *Europe confronts the embryonic stem cell research challenge*. Science 2000; 287(5457): 1425-7.
7. Young, F.E., *A time for restraint*. Science 2000; 287(5457): 1424.
8. Bongso, A., Fong, C.Y., and Gauthaman, K., *Taking stem cells to the clinic: Major challenges*. J Cell Biochem 2008; 105(6): 1352-60.
9. Lee, H., Park, J., Forget, B.G., and Gaines, P., *Induced pluripotent stem cells in regenerative medicine: an argument for continued research on human embryonic stem cells*. Regen Med 2009; 4(5): 759-69.
10. Deans, R.J. and Moseley, A.B., *Mesenchymal stem cells: biology and potential clinical uses*. Exp Hematol 2000; 28(8): 875-84.
11. Friedenstein, A.J., Chailakhjan, R.K., and Lalykina, K.S., *The development of fibroblast colonies in monolayer cultures of guinea-pig bone marrow and spleen cells*. Cell Tissue Kinet 1970; 3(4): 393-403.
12. Gronthos, S., Zannettino, A.C., Hay, S.J., Shi, S., Graves, S.E., Kortesidis, A., and Simmons, P.J., *Molecular and cellular characterisation of highly purified stromal stem cells derived from human bone marrow*. J Cell Sci 2003; 116(Pt 9): 1827-35.

13. Pittenger, M.F., Mackay, A.M., Beck, S.C., Jaiswal, R.K., Douglas, R., Mosca, J.D., Moorman, M.A., Simonetti, D.W., Craig, S., and Marshak, D.R., *Multilineage potential of adult human mesenchymal stem cells*. Science 1999; 284(5411): 143-7.
14. Iwami, Y., Masuda, H., and Asahara, T., *Endothelial progenitor cells: past, state of the art, and future*. J Cell Mol Med 2004; 8(4): 488-97.
15. Hristov, M. and Weber, C., *Endothelial progenitor cells: characterization, pathophysiology, and possible clinical relevance*. J Cell Mol Med 2004; 8(4): 498-508.
16. Patt, H.M. and Maloney, M.A., *Bone marrow regeneration after local injury: a review*. Exp Hematol 1975; 3(2): 135-48.
17. Friedenstein, A. and Kurolesova, A.I., *Osteogenic precursor cells of bone marrow in radiation chimeras*. Transplantation 1971; 12(2): 99-108.
18. Friedenstein, A.J., Petrakova, K.V., Kurolesova, A.I., and Frolova, G.P., *Heterotopic of bone marrow. Analysis of precursor cells for osteogenic and hematopoietic tissues*. Transplantation 1968; 6(2): 230-47.
19. Majumdar, M.K., Thiede, M.A., Mosca, J.D., Moorman, M., and Gerson, S.L., *Phenotypic and functional comparison of cultures of marrow-derived mesenchymal stem cells (MSCs) and stromal cells*. J Cell Physiol 1998; 176(1): 57-66.
20. Cheng, L., Qasba, P., Vanguri, P., and Thiede, M.A., *Human mesenchymal stem cells support megakaryocyte and pro-platelet formation from CD34(+) hematopoietic progenitor cells*. J Cell Physiol 2000; 184(1): 58-69.
21. Haynesworth, S.E., Baber, M.A., and Caplan, A.I., *Cytokine expression by human marrow-derived mesenchymal progenitor cells in vitro: effects of dexamethasone and IL-1 alpha*. J Cell Physiol 1996; 166(3): 585-92.
22. Neuss, S., Becher, E., Woltje, M., Tietze, L., and Jahnens-Decent, W., *Functional expression of HGF and HGF receptor/c-met in adult human mesenchymal stem cells suggests a role in cell mobilization, tissue repair, and wound healing*. Stem Cells 2004; 22(3): 405-14.
23. Bianco, P., Riminucci, M., Gronthos, S., and Robey, P.G., *Bone marrow stromal stem cells: nature, biology, and potential applications*. Stem Cells 2001; 19(3): 180-92.
24. Gronthos, S., Mankani, M., Brahim, J., Robey, P.G., and Shi, S., *Postnatal human dental pulp stem cells (DPSCs) in vitro and in vivo*. Proc Natl Acad Sci U S A 2000; 97(25): 13625-30.

25. Smith, J.R., Pochampally, R., Perry, A., Hsu, S.C., and Prockop, D.J., *Isolation of a highly clonogenic and multipotential subfraction of adult stem cells from bone marrow stroma*. Stem Cells 2004; 22(5): 823-31.
26. Horwitz, E.M., Prockop, D.J., Fitzpatrick, L.A., Koo, W.W., Gordon, P.L., Neel, M., Sussman, M., Orchard, P., Marx, J.C., Pyeritz, R.E., and Brenner, M.K., *Transplantability and therapeutic effects of bone marrow-derived mesenchymal cells in children with osteogenesis imperfecta*. Nat Med 1999; 5(3): 309-13.
27. Pereira, R.F., Halford, K.W., O'Hara, M.D., Leeper, D.B., Sokolov, B.P., Pollard, M.D., Bagasra, O., and Prockop, D.J., *Cultured adherent cells from marrow can serve as long-lasting precursor cells for bone, cartilage, and lung in irradiated mice*. Proc Natl Acad Sci U S A 1995; 92(11): 4857-61.
28. Jiang, Y., Jahagirdar, B.N., Reinhardt, R.L., Schwartz, R.E., Keene, C.D., Ortiz-Gonzalez, X.R., Reyes, M., Lenvik, T., Lund, T., Blackstad, M., Du, J., Aldrich, S., Lisberg, A., Low, W.C., Largaespada, D.A., and Verfaillie, C.M., *Pluripotency of mesenchymal stem cells derived from adult marrow*. Nature 2002; 418(6893): 41-9.
29. Woodbury, D., Schwarz, E.J., Prockop, D.J., and Black, I.B., *Adult rat and human bone marrow stromal cells differentiate into neurons*. J Neurosci Res 2000; 61(4): 364-70.
30. Petersen, B.E., Bowen, W.C., Patrene, K.D., Mars, W.M., Sullivan, A.K., Murase, N., Boggs, S.S., Greenberger, J.S., and Goff, J.P., *Bone marrow as a potential source of hepatic oval cells*. Science 1999; 284(5417): 1168-70.
31. Gronthos, S., Chen, S., Wang, C.Y., Robey, P.G., and Shi, S., *Telomerase accelerates osteogenesis of bone marrow stromal stem cells by upregulation of CBFA1, osterix, and osteocalcin*. J Bone Miner Res 2003; 18(4): 716-22.
32. da Silva Meirelles, L., Chagastelles, P.C., and Nardi, N.B., *Mesenchymal stem cells reside in virtually all post-natal organs and tissues*. J Cell Sci 2006; 119(Pt 11): 2204-13.
33. Krampera, M., Pizzolo, G., Aprili, G., and Franchini, M., *Mesenchymal stem cells for bone, cartilage, tendon and skeletal muscle repair*. Bone 2006; 39(4): 678-83.
34. Friedenstein, A.J., Piatetzky, S., II, and Petrakova, K.V., *Osteogenesis in transplants of bone marrow cells*. J Embryol Exp Morphol 1966; 16(3): 381-90.
35. Friedenstein, A.J., Gorskaja, J.F., and Kulagina, N.N., *Fibroblast precursors in normal and irradiated mouse hematopoietic organs*. Exp Hematol 1976; 4(5): 267-74.

36. Caplan, A.I., *Mesenchymal stem cells*. J Orthop Res 1991; 9(5): 641-50.
37. Horwitz, E.M., Le Blanc, K., Dominici, M., Mueller, I., Slaper-Cortenbach, I., Marini, F.C., Deans, R.J., Krause, D.S., and Keating, A., *Clarification of the nomenclature for MSC: The International Society for Cellular Therapy position statement*. Cytotherapy 2005; 7(5): 393-5.
38. Dominici, M., Le Blanc, K., Mueller, I., Slaper-Cortenbach, I., Marini, F., Krause, D., Deans, R., Keating, A., Prockop, D., and Horwitz, E., *Minimal criteria for defining multipotent mesenchymal stromal cells. The International Society for Cellular Therapy position statement*. Cytotherapy 2006; 8(4): 315-7.
39. Zannettino, A.C., Paton, S., Arthur, A., Khor, F., Itescu, S., Gimble, J.M., and Gronthos, S., *Multipotential human adipose-derived stromal stem cells exhibit a perivascular phenotype in vitro and in vivo*. J Cell Physiol 2008; 214(2): 413-21.
40. Kuznetsov, S.A., Mankani, M.H., Gronthos, S., Satomura, K., Bianco, P., and Robey, P.G., *Circulating skeletal stem cells*. J Cell Biol 2001; 153(5): 1133-40.
41. Seo, B.M., Miura, M., Gronthos, S., Bartold, P.M., Batouli, S., Brahim, J., Young, M., Robey, P.G., Wang, C.Y., and Shi, S., *Investigation of multipotent postnatal stem cells from human periodontal ligament*. Lancet 2004; 364(9429): 149-55.
42. Erices, A., Conget, P., and Minguell, J.J., *Mesenchymal progenitor cells in human umbilical cord blood*. Br J Haematol 2000; 109(1): 235-42.
43. Portmann-Lanz, C.B., Schoeberlein, A., Huber, A., Sager, R., Malek, A., Holzgreve, W., and Surbek, D.V., *Placental mesenchymal stem cells as potential autologous graft for pre- and perinatal neuroregeneration*. Am J Obstet Gynecol 2006; 194(3): 664-73.
44. Soncini, M., Vertua, E., Gibelli, L., Zorzi, F., Denegri, M., Albertini, A., Wengler, G.S., and Parolini, O., *Isolation and characterization of mesenchymal cells from human fetal membranes*. J Tissue Eng Regen Med 2007; 1(4): 296-305.
45. in 't Anker, P.S., Noort, W.A., Scherjon, S.A., Kleijburg-van der Keur, C., Kruisselbrink, A.B., van Bezooijen, R.L., Beekhuizen, W., Willemze, R., Kanhai, H.H., and Fibbe, W.E., *Mesenchymal stem cells in human second-trimester bone marrow, liver, lung, and spleen exhibit a similar immunophenotype but a heterogeneous multilineage differentiation potential*. Haematologica 2003; 88(8): 845-52.
46. In 't Anker, P.S., Scherjon, S.A., Kleijburg-van der Keur, C., de Groot-Swings, G.M., Claas, F.H., Fibbe, W.E., and Kanhai, H.H., *Isolation of mesenchymal stem*

- cells of fetal or maternal origin from human placenta.* Stem Cells 2004; 22(7): 1338-45.
47. Young, H.E., Steele, T.A., Bray, R.A., Hudson, J., Floyd, J.A., Hawkins, K., Thomas, K., Austin, T., Edwards, C., Cuzzourt, J., Duenzl, M., Lucas, P.A., and Black, A.C., Jr., *Human reserve pluripotent mesenchymal stem cells are present in the connective tissues of skeletal muscle and dermis derived from fetal, adult, and geriatric donors.* Anat Rec 2001; 264(1): 51-62.
48. Barberi, T., Willis, L.M., Soccia, N.D., and Studer, L., *Derivation of multipotent mesenchymal precursors from human embryonic stem cells.* PLoS Med 2005; 2(6): e161.
49. Nakano, T., Kodama, H., and Honjo, T., *Generation of lymphohematopoietic cells from embryonic stem cells in culture.* Science 1994; 265(5175): 1098-101.
50. Olivier, E.N., Rybicki, A.C., and Bouhassira, E.E., *Differentiation of human embryonic stem cells into bipotent mesenchymal stem cells.* Stem Cells 2006; 24(8): 1914-22.
51. Lian, Q., Lye, E., Suan Yeo, K., Khia Way Tan, E., Salto-Tellez, M., Liu, T.M., Palanisamy, N., El Oakley, R.M., Lee, E.H., Lim, B., and Lim, S.K., *Derivation of clinically compliant MSCs from CD105+, CD24- differentiated human ESCs.* Stem Cells 2007; 25(2): 425-36.
52. Lian, Q., Zhang, Y., Zhang, J., Zhang, H.K., Wu, X., Lam, F.F., Kang, S., Xia, J.C., Lai, W.H., Au, K.W., Chow, Y.Y., Siu, C.W., Lee, C.N., and Tse, H.F., *Functional mesenchymal stem cells derived from human induced pluripotent stem cells attenuate limb ischemia in mice.* Circulation 2010; 121(9): 1113-23.
53. Kuznetsov, S.A., Krebsbach, P.H., Satomura, K., Kerr, J., Riminucci, M., Benayahu, D., and Robey, P.G., *Single-colony derived strains of human marrow stromal fibroblasts form bone after transplantation in vivo.* J Bone Miner Res 1997; 12(9): 1335-47.
54. Simmons, P.J. and Torok-Storb, B., *Identification of stromal cell precursors in human bone marrow by a novel monoclonal antibody, STRO-1.* Blood 1991; 78(1): 55-62.
55. Gronthos, S., Graves, S.E., Ohta, S., and Simmons, P.J., *The STRO-1+ fraction of adult human bone marrow contains the osteogenic precursors.* Blood 1994; 84(12): 4164-73.

56. Dennis, J.E. and Charbord, P., *Origin and differentiation of human and murine stroma*. Stem Cells 2002; 20(3): 205-14.
57. Tamayo, E., Charbord, P., Li, J., and Herve, P., *A quantitative assay that evaluates the capacity of human stromal cells to support granulomonopoiesis in situ*. Stem Cells 1994; 12(3): 304-15.
58. Shi, S. and Gronthos, S., *Perivascular niche of postnatal mesenchymal stem cells in human bone marrow and dental pulp*. J Bone Miner Res 2003; 18(4): 696-704.
59. Shih, I.M., *The role of CD146 (Mel-CAM) in biology and pathology*. J Pathol 1999; 189(1): 4-11.
60. Sacchetti, B., Funari, A., Michienzi, S., Di Cesare, S., Piersanti, S., Saggio, I., Tagliafico, E., Ferrari, S., Robey, P.G., Riminucci, M., and Bianco, P., *Self-renewing osteoprogenitors in bone marrow sinusoids can organize a hematopoietic microenvironment*. Cell 2007; 131(2): 324-36.
61. Simmons, P.J., Masinovsky, B., Longenecker, B.M., Berenson, R., Torok-Storb, B., and Gallatin, W.M., *Vascular cell adhesion molecule-1 expressed by bone marrow stromal cells mediates the binding of hematopoietic progenitor cells*. Blood 1992; 80(2): 388-95.
62. Tanaka-Douzono, M., Suzu, S., Yamada, M., Wakimoto, N., Hayasawa, H., Hatake, K., and Motoyoshi, K., *Detection of murine adult bone marrow stroma-initiating cells in Lin(-)c-fms(+)c-kit(low)VCAM-1(+) cells*. J Cell Physiol 2001; 189(1): 45-53.
63. Yamada, M., Suzu, S., Tanaka-Douzono, M., Wakimoto, N., Hatake, K., Hayasawa, H., and Motoyoshi, K., *Effect of cytokines on the proliferation/differentiation of stroma-initiating cells*. J Cell Physiol 2000; 184(3): 351-5.
64. Sariban, E., Mitchell, T., and Kufe, D., *Expression of the c-fms proto-oncogene during human monocytic differentiation*. Nature 1985; 316(6023): 64-6.
65. Rettenmier, C.W., Roussel, M.F., and Sherr, C.J., *The colony-stimulating factor 1 (CSF-1) receptor (c-fms proto-oncogene product) and its ligand*. J Cell Sci Suppl 1988; 9: 27-44.
66. Yamaguchi, Y., Gunji, Y., Nakamura, M., Hayakawa, K., Maeda, M., Osawa, H., Nagayoshi, K., Kasahara, T., and Suda, T., *Expression of c-kit mRNA and protein during the differentiation of human hematopoietic progenitor cells*. Exp Hematol 1993; 21(9): 1233-8.

67. Kumar, A.G., Dai, X.Y., Kozak, C.A., Mims, M.P., Gotto, A.M., and Ballantyne, C.M., *Murine VCAM-1. Molecular cloning, mapping, and analysis of a truncated form.* J Immunol 1994; 153(9): 4088-98.
68. Jones, E.A., Kinsey, S.E., English, A., Jones, R.A., Straszynski, L., Meredith, D.M., Markham, A.F., Jack, A., Emery, P., and McGonagle, D., *Isolation and characterization of bone marrow multipotential mesenchymal progenitor cells.* Arthritis Rheum 2002; 46(12): 3349-60.
69. Deschaseaux, F. and Charbord, P., *Human marrow stromal precursors are alpha 1 integrin subunit-positive.* J Cell Physiol 2000; 184(3): 319-25.
70. Deschaseaux, F., Gindraux, F., Saadi, R., Obert, L., Chalmers, D., and Herve, P., *Direct selection of human bone marrow mesenchymal stem cells using an anti-CD49a antibody reveals their CD45med,low phenotype.* Br J Haematol 2003; 122(3): 506-17.
71. Gronthos, S., Simmons, P.J., Graves, S.E., and Robey, P.G., *Integrin-mediated interactions between human bone marrow stromal precursor cells and the extracellular matrix.* Bone 2001; 28(2): 174-81.
72. Aslan, H., Zilberman, Y., Kandel, L., Liebergall, M., Oskouian, R.J., Gazit, D., and Gazit, Z., *Osteogenic differentiation of noncultured immunoisolated bone marrow-derived CD105+ cells.* Stem Cells 2006; 24(7): 1728-37.
73. Kastrinaki, M.C., Andreakou, I., Charbord, P., and Papadaki, H.A., *Isolation of human bone marrow mesenchymal stem cells using different membrane markers: comparison of colony/cloning efficiency, differentiation potential, and molecular profile.* Tissue Eng Part C Methods 2008; 14(4): 333-9.
74. Chen, C.Z., Li, L., Li, M., and Lodish, H.F., *The endoglin(positive) sca-1(positive) rhodamine(low) phenotype defines a near-homogeneous population of long-term repopulating hematopoietic stem cells.* Immunity 2003; 19(4): 525-33.
75. Gronthos, S., Fitter, S., Diamond, P., Simmons, P.J., Itescu, S., and Zannettino, A.C., *A novel monoclonal antibody (STRO-3) identifies an isoform of tissue nonspecific alkaline phosphatase expressed by multipotent bone marrow stromal stem cells.* Stem Cells Dev 2007; 16(6): 953-63.
76. Gronthos, S., McCarty, R., Mrozik, K., Fitter, S., Paton, S., Menicanin, D., Itescu, S., Bartold, P.M., Xian, C., and Zannettino, A.C., *Heat shock protein-90 beta is expressed at the surface of multipotential mesenchymal precursor cells: generation of a novel monoclonal antibody, STRO-4, with specificity for mesenchymal*

- precursor cells from human and ovine tissues.* Stem Cells Dev 2009; 18(9): 1253-62.
77. Haynesworth, S.E., Baber, M.A., and Caplan, A.I., *Cell surface antigens on human marrow-derived mesenchymal cells are detected by monoclonal antibodies.* Bone 1992; 13(1): 69-80.
78. Xu, W., Zhang, X., Qian, H., Zhu, W., Sun, X., Hu, J., Zhou, H., and Chen, Y., *Mesenchymal stem cells from adult human bone marrow differentiate into a cardiomyocyte phenotype in vitro.* Exp Biol Med (Maywood) 2004; 229(7): 623-31.
79. Galmiche, M.C., Koteliansky, V.E., Briere, J., Herve, P., and Charbord, P., *Stromal cells from human long-term marrow cultures are mesenchymal cells that differentiate following a vascular smooth muscle differentiation pathway.* Blood 1993; 82(1): 66-76.
80. Conget, P.A. and Minguell, J.J., *Phenotypical and functional properties of human bone marrow mesenchymal progenitor cells.* J Cell Physiol 1999; 181(1): 67-73.
81. Sordi, V., Malosio, M.L., Marchesi, F., Mercalli, A., Melzi, R., Giordano, T., Belmonte, N., Ferrari, G., Leone, B.E., Bertuzzi, F., Zerbini, G., Allavena, P., Bonifacio, E., and Piemonti, L., *Bone marrow mesenchymal stem cells express a restricted set of functionally active chemokine receptors capable of promoting migration to pancreatic islets.* Blood 2005; 106(2): 419-27.
82. Le Blanc, K., Tammik, C., Rosendahl, K., Zetterberg, E., and Ringden, O., *HLA expression and immunologic properties of differentiated and undifferentiated mesenchymal stem cells.* Exp Hematol 2003; 31(10): 890-6.
83. Thesleff, I. and Sharpe, P., *Signalling networks regulating dental development.* Mech Dev 1997; 67(2): 111-23.
84. Jernvall, J. and Thesleff, I., *Reiterative signaling and patterning during mammalian tooth morphogenesis.* Mech Dev 2000; 92(1): 19-29.
85. Pispa, J. and Thesleff, I., *Mechanisms of ectodermal organogenesis.* Dev Biol 2003; 262(2): 195-205.
86. Anderson, L. and Seilhamer, J., *A comparison of selected mRNA and protein abundances in human liver.* Electrophoresis 1997; 18(3-4): 533-7.
87. Thesleff, I., Partanen, A.M., and Vainio, S., *Epithelial-mesenchymal interactions in tooth morphogenesis: the roles of extracellular matrix, growth factors, and cell surface receptors.* J Craniofac Genet Dev Biol 1991; 11(4): 229-37.

88. Thesleff, I., Vaahtokari, A., Kettunen, P., and Aberg, T., *Epithelial-mesenchymal signaling during tooth development*. Connect Tissue Res 1995; 32(1-4): 9-15.
89. Nakashima, M. and Reddi, A.H., *The application of bone morphogenetic proteins to dental tissue engineering*. Nat Biotechnol 2003; 21(9): 1025-32.
90. Cate, T., *Ten Cate's Oral Histology: Development, Structure and Function*. 2003: CV Mosbey.
91. Duailibi, S.E., Duailibi, M.T., Vacanti, J.P., and Yelick, P.C., *Prospects for tooth regeneration*. Periodontol 2000 2006; 41: 177-87.
92. Gould, T.R., Melcher, A.H., and Brunette, D.M., *Migration and division of progenitor cell populations in periodontal ligament after wounding*. J Periodontal Res 1980; 15(1): 20-42.
93. Beertsen, W., McCulloch, C.A., and Sodek, J., *The periodontal ligament: a unique, multifunctional connective tissue*. Periodontol 2000 1997; 13: 20-40.
94. Boyko, G.A., Melcher, A.H., and Brunette, D.M., *Formation of new periodontal ligament by periodontal ligament cells implanted in vivo after culture in vitro. A preliminary study of transplanted roots in the dog*. J Periodontal Res 1981; 16(1): 73-88.
95. Liu, H.W., Yacobi, R., Savion, N., Narayanan, A.S., and Pitaru, S., *A collagenous cementum-derived attachment protein is a marker for progenitors of the mineralized tissue-forming cell lineage of the periodontal ligament*. J Bone Miner Res 1997; 12(10): 1691-9.
96. Miura, M., Gronthos, S., Zhao, M., Lu, B., Fisher, L.W., Robey, P.G., and Shi, S., *SHED: stem cells from human exfoliated deciduous teeth*. Proc Natl Acad Sci U S A 2003; 100(10): 5807-12.
97. Gronthos, S., Brahim, J., Li, W., Fisher, L.W., Cherman, N., Boyde, A., DenBesten, P., Robey, P.G., and Shi, S., *Stem cell properties of human dental pulp stem cells*. J Dent Res 2002; 81(8): 531-5.
98. Mjor, I.A. and Fejerskov, O., *Human Oral Embryology and Histology*. 1st ed. 1986, Copenhagen: Munksgaard.
99. Ten Cate, A.R., *Oral Histology, Development, Structure and Function*. 3rd ed, ed. Reinhardt, R.W. 1989, Toronto: C.V. Mosby Company.
100. Frank, R.M., *Ultrastructural relationship between the odontoblast, its process and the nerve fibre*. Dentine and Pulp: Their structure and reaction, ed. Symmons, N.B.B. 1968, Edinburgh, UK: Churchill Livingstone.

101. Harris, R. and Griffin, C.J., *The fine structure of the mature odontoblasts and cell rich zone of the human dental pulp.* Aust Dent J 1969; 14(3): 168-77.
102. Bergenholz, G., *Inflammatory response of the dental pulp to bacterial irritation.* J Endod 1981; 7(3): 100-4.
103. Stanley, H.R., *Human Pulp Response to Restorative Dental Procedures* 1981, Grainesville: Storter Printing Company.
104. Trowbridge, H.O., *Pathogenesis of pulpitis resulting from dental caries.* J Endod 1981; 7(2): 52-60.
105. Larmas, M., *Response of pulpo-dentinal complex to caries attack.* Proc Finn Dent Soc 1986; 82(5-6): 298-304.
106. Langeland, K., *Tissue response to dental caries.* Endod Dent Traumatol 1987; 3(4): 149-71.
107. Smith, A.J., Cassidy, N., Perry, H., Begue-Kirn, C., Ruch, J.V., and Lesot, H., *Reactionary dentinogenesis.* Int J Dev Biol 1995; 39(1): 273-80.
108. Byers, M.R. and Narhi, M.V., *Dental injury models: experimental tools for understanding neuroinflammatory interactions and polymodal nociceptor functions.* Crit Rev Oral Biol Med 1999; 10(1): 4-39.
109. Mjor, I.A., *Dentin and Pulp, Reaction Patterns in Human Teeth*, ed. Raton, F.L.B. 1983: CRC Press.
110. Shi, S., Robey, P.G., and Gronthos, S., *Comparison of human dental pulp and bone marrow stromal stem cells by cDNA microarray analysis.* Bone 2001; 29(6): 532-9.
111. Butler, W.T., Ritchie, H.H., and Bronckers, A.L., *Extracellular matrix proteins of dentine.* Ciba Found Symp 1997; 205: 107-15; discussion 115-7.
112. Butler, W.T. and Ritchie, H., *The nature and functional significance of dentin extracellular matrix proteins.* Int J Dev Biol 1995; 39(1): 169-79.
113. Boskey, A.L., *Matrix proteins and mineralization: an overview.* Connect Tissue Res 1996; 35(1-4): 357-63.
114. Damsky, C.H., *Extracellular matrix-integrin interactions in osteoblast function and tissue remodeling.* Bone 1999; 25(1): 95-6.
115. Noonan, K.J., Stevens, J.W., Tammi, R., Tammi, M., Hernandez, J.A., and Midura, R.J., *Spatial distribution of CD44 and hyaluronan in the proximal tibia of the growing rat.* J Orthop Res 1996; 14(4): 573-81.

116. Robey, P.G., *Vertebrate mineralized matrix proteins: structure and function.* Connect Tissue Res 1996; 35(1-4): 131-6.
117. Tanaka, Y., Morimoto, I., Nakano, Y., Okada, Y., Hirota, S., Nomura, S., Nakamura, T., and Eto, S., *Osteoblasts are regulated by the cellular adhesion through ICAM-1 and VCAM-1.* J Bone Miner Res 1995; 10(10): 1462-9.
118. Zimmerman, D., Jin, F., Leboy, P., Hardy, S., and Damsky, C., *Impaired bone formation in transgenic mice resulting from altered integrin function in osteoblasts.* Dev Biol 2000; 220(1): 2-15.
119. Ducy, P. and Karsenty, G., *The family of bone morphogenetic proteins.* Kidney Int 2000; 57(6): 2207-14.
120. Karsenty, G., *The genetic transformation of bone biology.* Genes Dev 1999; 13(23): 3037-51.
121. McCarthy, T.L., Ji, C., and Centrella, M., *Links among growth factors, hormones, and nuclear factors with essential roles in bone formation.* Crit Rev Oral Biol Med 2000; 11(4): 409-22.
122. Montero, A., Okada, Y., Tomita, M., Ito, M., Tsurukami, H., Nakamura, T., Doetschman, T., Coffin, J.D., and Hurley, M.M., *Disruption of the fibroblast growth factor-2 gene results in decreased bone mass and bone formation.* J Clin Invest 2000; 105(8): 1085-93.
123. Heikinheimo, K., Begue-Kirn, C., Ritvos, O., Tuuri, T., and Ruch, J.V., *Activin and bone morphogenetic protein (BMP) signalling during tooth development.* Eur J Oral Sci 1998; 106 Suppl 1: 167-73.
124. Russo, L.G., Maharajan, P., and Maharajan, V., *Basic fibroblast growth factor (FGF-2) in mouse tooth morphogenesis.* Growth Factors 1998; 15(2): 125-33.
125. Hoffman, R.L., *Bone formation and resorption around developing teeth transplanted into the femur.* Am J Anat 1966; 118(1): 91-102.
126. Schroeder, H.E., *Handbook of microscopic anatomy.* The Periodontium. Vol. 5. 1986, Berlin: Springer-Verlag. 12-323.
127. McCulloch, C.A., Lekic, P., and McKee, M.D., *Role of physical forces in regulating the form and function of the periodontal ligament.* Periodontol 2000 2000; 24: 56-72.
128. Berkovitz, B.K., *The structure of the periodontal ligament: an update.* Eur J Orthod 1990; 12(1): 51-76.

129. Sodek, J., *A new approach to assessing collagen turnover by using a micro-assay. A highly efficient and rapid turnover of collagen in rat periodontal tissues.* Biochem J 1976; 160(2): 243-6.
130. McCulloch, C.A., Nemeth, E., Lowenberg, B., and Melcher, A.H., *Paravascular cells in endosteal spaces of alveolar bone contribute to periodontal ligament cell populations.* Anat Rec 1987; 219(3): 233-42.
131. Bartold, P.M. and Narayanan, A.S., *Periodontal regeneration: biology of the periodontal connective tissues.* 1998, Chicago: Quintessence Publishing.
132. Bartold, P.M., Shi, S., and Gronthos, S., *Stem cells and periodontal regeneration.* Periodontol 2000 2006; 40: 164-72.
133. Chen, S.C., Marino, V., Gronthos, S., and Bartold, P.M., *Location of putative stem cells in human periodontal ligament.* J Periodontal Res 2006; 41(6): 547-53.
134. Zannettino, A.C., Paton, S., Arthur, A., Khor, F., Itescu, S., Gimble, J.M., and Gronthos, S., *Multipotential human adipose-derived stromal stem cells exhibit a perivascular phenotype in vitro and in vivo.* J Cell Physiol 2007.
135. Gronthos, S., Mrozik, K., Shi, S., and Bartold, P.M., *Ovine periodontal ligament stem cells: isolation, characterization, and differentiation potential.* Calcif Tissue Int 2006; 79(5): 310-7.
136. Nakashima, M., *Bone morphogenetic proteins in dentin regeneration for potential use in endodontic therapy.* Cytokine Growth Factor Rev 2005; 16(3): 369-76.
137. Srisuwan, T., Tilkorn, D.J., Wilson, J.L., Morrison, W.A., Messer, H.M., Thompson, E.W., and Abberton, K.M., *Molecular aspects of tissue engineering in the dental field.* Periodontol 2000 2006; 41: 88-108.
138. Wagner, W., Wein, F., Seckinger, A., Frankhauser, M., Wirkner, U., Krause, U., Blake, J., Schwager, C., Eckstein, V., Ansorge, W., and Ho, A.D., *Comparative characteristics of mesenchymal stem cells from human bone marrow, adipose tissue, and umbilical cord blood.* Exp Hematol 2005; 33(11): 1402-16.
139. Bruder, S.P., Jaiswal, N., Ricalton, N.S., Mosca, J.D., Kraus, K.H., and Kadiyala, S., *Mesenchymal stem cells in osteobiology and applied bone regeneration.* Clin Orthop Relat Res 1998; (355 Suppl): S247-56.
140. Derubeis, A.R. and Cancedda, R., *Bone marrow stromal cells (BMSCs) in bone engineering: limitations and recent advances.* Ann Biomed Eng 2004; 32(1): 160-5.

141. Caplan, A.I., *Review: mesenchymal stem cells: cell-based reconstructive therapy in orthopedics.* Tissue Eng 2005; 11(7-8): 1198-211.
142. Bianco, P., Kuznetsov, S.A., Riminucci, M., and Gehron Robey, P., *Postnatal skeletal stem cells.* Methods Enzymol 2006; 419: 117-48.
143. Caplan, A.I., *Adult mesenchymal stem cells for tissue engineering versus regenerative medicine.* J Cell Physiol 2007; 213(2): 341-7.
144. Arthur, A., Zannettino, A., and Gronthos, S., *The therapeutic applications of multipotential mesenchymal/stromal stem cells in skeletal tissue repair.* J Cell Physiol 2008.
145. Kode, J.A., Mukherjee, S., Joglekar, M.V., and Hardikar, A.A., *Mesenchymal stem cells: immunobiology and role in immunomodulation and tissue regeneration.* Cytotherapy 2009; 11(4): 377-91.
146. Bruder, S.P., Kraus, K.H., Goldberg, V.M., and Kadiyala, S., *The effect of implants loaded with autologous mesenchymal stem cells on the healing of canine segmental bone defects.* J Bone Joint Surg Am 1998; 80(7): 985-96.
147. Brodke, D., Pedrozo, H.A., Kapur, T.A., Attawia, M., Kraus, K.H., Holy, C.E., Kadiyala, S., and Bruder, S.P., *Bone grafts prepared with selective cell retention technology heal canine segmental defects as effectively as autograft.* J Orthop Res 2006; 24(5): 857-66.
148. Marcacci, M., Kon, E., Zaffagnini, S., Giardino, R., Rocca, M., Corsi, A., Benvenuti, A., Bianco, P., Quarto, R., Martin, I., Muraglia, A., and Cancedda, R., *Reconstruction of extensive long-bone defects in sheep using porous hydroxyapatite sponges.* Calcif Tissue Int 1999; 64(1): 83-90.
149. Kon, E., Muraglia, A., Corsi, A., Bianco, P., Marcacci, M., Martin, I., Boyde, A., Ruspantini, I., Chistolini, P., Rocca, M., Giardino, R., Cancedda, R., and Quarto, R., *Autologous bone marrow stromal cells loaded onto porous hydroxyapatite ceramic accelerate bone repair in critical-size defects of sheep long bones.* J Biomed Mater Res 2000; 49(3): 328-37.
150. Viateau, V., Guillemin, G., Bousson, V., Oudina, K., Hannouche, D., Sedel, L., Logeart-Avramoglou, D., and Petite, H., *Long-bone critical-size defects treated with tissue-engineered grafts: a study on sheep.* J Orthop Res 2007; 25(6): 741-9.
151. Bensaid, W., Oudina, K., Viateau, V., Potier, E., Bousson, V., Blanchat, C., Sedel, L., Guillemin, G., and Petite, H., *De novo reconstruction of functional bone by*

- tissue engineering in the metatarsal sheep model.* Tissue Eng 2005; 11(5-6): 814-24.
152. Petite, H., Viateau, V., Bensaid, W., Meunier, A., de Pollak, C., Bourguignon, M., Oudina, K., Sedel, L., and Guillemin, G., *Tissue-engineered bone regeneration.* Nat Biotechnol 2000; 18(9): 959-63.
153. Liu, G., Zhao, L., Zhang, W., Cui, L., Liu, W., and Cao, Y., *Repair of goat tibial defects with bone marrow stromal cells and beta-tricalcium phosphate.* J Mater Sci Mater Med 2008; 19(6): 2367-76.
154. Liu, X., Li, X., Fan, Y., Zhang, G., Li, D., Dong, W., Sha, Z., Yu, X., Feng, Q., Cui, F., and Watari, F., *Repairing goat tibia segmental bone defect using scaffold cultured with mesenchymal stem cells.* J Biomed Mater Res B Appl Biomater 2010.
155. Muraglia, A., Martin, I., Cancedda, R., and Quarto, R., *A nude mouse model for human bone formation in unloaded conditions.* Bone 1998; 22(5 Suppl): 131S-134S.
156. Arinzech, T.L., Peter, S.J., Archambault, M.P., van den Bos, C., Gordon, S., Kraus, K., Smith, A., and Kadiyala, S., *Allogeneic mesenchymal stem cells regenerate bone in a critical-sized canine segmental defect.* J Bone Joint Surg Am 2003; 85-A(10): 1927-35.
157. Dai, K.R., Xu, X.L., Tang, T.T., Zhu, Z.A., Yu, C.F., Lou, J.R., and Zhang, X.L., *Repairing of goat tibial bone defects with BMP-2 gene-modified tissue-engineered bone.* Calcif Tissue Int 2005; 77(1): 55-61.
158. Zhu, L., Liu, W., Cui, L., and Cao, Y., *Tissue-engineered bone repair of goat-femur defects with osteogenically induced bone marrow stromal cells.* Tissue Eng 2006; 12(3): 423-33.
159. Yuan, J., Cui, L., Zhang, W.J., Liu, W., and Cao, Y., *Repair of canine mandibular bone defects with bone marrow stromal cells and porous beta-tricalcium phosphate.* Biomaterials 2007; 28(6): 1005-13.
160. Quarto, R., Mastrogiacomo, M., Cancedda, R., Kutepov, S.M., Mukhachev, V., Lavroukov, A., Kon, E., and Marcacci, M., *Repair of large bone defects with the use of autologous bone marrow stromal cells.* N Engl J Med 2001; 344(5): 385-6.
161. Dorotka, R., Windberger, U., Macfelda, K., Bindreiter, U., Toma, C., and Nehrer, S., *Repair of articular cartilage defects treated by microfracture and a three-dimensional collagen matrix.* Biomaterials 2005; 26(17): 3617-29.

162. Mrugala, D., Bony, C., Neves, N., Caillot, L., Fabre, S., Moukoko, D., Jorgensen, C., and Noel, D., *Phenotypic and functional characterisation of ovine mesenchymal stem cells: application to a cartilage defect model.* Ann Rheum Dis 2008; 67(3): 288-95.
163. Quintavalla, J., Uziel-Fusi, S., Yin, J., Boehlein, E., Pastor, G., Blancuzzi, V., Singh, H.N., Kraus, K.H., O'Byrne, E., and Pellas, T.C., *Fluorescently labeled mesenchymal stem cells (MSCs) maintain multilineage potential and can be detected following implantation into articular cartilage defects.* Biomaterials 2002; 23(1): 109-19.
164. Murphy, J.M., Fink, D.J., Hunziker, E.B., and Barry, F.P., *Stem cell therapy in a caprine model of osteoarthritis.* Arthritis Rheum 2003; 48(12): 3464-74.
165. Laino, G., d'Aquino, R., Graziano, A., Lanza, V., Carinci, F., Naro, F., Pirozzi, G., and Papaccio, G., *A new population of human adult dental pulp stem cells: a useful source of living autologous fibrous bone tissue (LAB).* J Bone Miner Res 2005; 20(8): 1394-402.
166. Nakashima, M. and Akamine, A., *The application of tissue engineering to regeneration of pulp and dentin in endodontics.* J Endod 2005; 31(10): 711-8.
167. Zhang, W., Walboomers, X.F., Van Kuppevelt, T.H., Daamen, W.F., Van Damme, P.A., Bian, Z., and Jansen, J.A., *In vivo evaluation of human dental pulp stem cells differentiated towards multiple lineages.* J Tissue Eng Regen Med 2008; 2(2-3): 117-25.
168. Yamada, Y., Nakamura, S., Ito, K., Sugito, T., Yoshimi, R., Nagasaka, T., and Ueda, M., *A Feasibility of Useful Cell-Based Therapy by Bone Regeneration with Deciduous Tooth Stem Cells, Dental Pulp Stem Cells, or Bone-Marrow-Derived Mesenchymal Stem Cells for Clinical Study Using Tissue Engineering Technology.* Tissue Eng Part A 2010.
169. d'Aquino, R., De Rosa, A., Lanza, V., Tirino, V., Laino, L., Graziano, A., Desiderio, V., Laino, G., and Papaccio, G., *Human mandible bone defect repair by the grafting of dental pulp stem/progenitor cells and collagen sponge biocomplexes.* Eur Cell Mater 2009; 18: 75-83.
170. Lang, H., Schuler, N., Arnhold, S., Nolden, R., and Mertens, T., *Formation of differentiated tissues in vivo by periodontal cell populations cultured in vitro.* J Dent Res 1995; 74(5): 1219-25.

171. Lang, H., Schuler, N., and Nolden, R., *Attachment formation following replantation of cultured cells into periodontal defects--a study in minipigs.* J Dent Res 1998; 77(2): 393-405.
172. Sonoyama, W., Liu, Y., Fang, D., Yamaza, T., Seo, B.M., Zhang, C., Liu, H., Gronthos, S., Wang, C.Y., Shi, S., and Wang, S., *Mesenchymal stem cell-mediated functional tooth regeneration in Swine.* PLoS ONE 2006; 1: e79.
173. Liu, Y., Zheng, Y., Ding, G., Fang, D., Zhang, C., Bartold, P.M., Gronthos, S., Shi, S., and Wang, S., *Periodontal ligament stem cell-mediated treatment for periodontitis in miniature swine.* Stem Cells 2008; 26(4): 1065-73.
174. Kim, S.H., Kim, K.H., Seo, B.M., Koo, K.T., Kim, T.I., Seol, Y.J., Ku, Y., Rhyu, I.C., Chung, C.P., and Lee, Y.M., *Alveolar bone regeneration by transplantation of periodontal ligament stem cells and bone marrow stem cells in a canine peri-implant defect model: a pilot study.* J Periodontol 2009; 80(11): 1815-23.
175. Feng, F., Akiyama, K., Liu, Y., Yamaza, T., Wang, T.M., Chen, J.H., Wang, B.B., Huang, G.T., Wang, S., and Shi, S., *Utility of PDL progenitors for in vivo tissue regeneration: a report of 3 cases.* Oral Dis 2010; 16(1): 20-8.
176. Colter, D.C., Sekiya, I., and Prockop, D.J., *Identification of a subpopulation of rapidly self-renewing and multipotential adult stem cells in colonies of human marrow stromal cells.* Proc Natl Acad Sci U S A 2001; 98(14): 7841-5.
177. Menicanin, D., Bartold, P.M., Zannettino, A.C., and Gronthos, S., *Identification of a Common Gene Expression Signature Associated with Immature Clonal Mesenchymal Cell Populations derived from Bone Marrow and Dental Tissues.* Stem Cells Dev 2010.
178. Phinney, D.G., *Biochemical heterogeneity of mesenchymal stem cell populations: clues to their therapeutic efficacy.* Cell Cycle 2007; 6(23): 2884-9.
179. Ho, A.D., Wagner, W., and Franke, W., *Heterogeneity of mesenchymal stromal cell preparations.* Cytotherapy 2008; 10(4): 320-30.
180. Lander, E.S., Linton, L.M., Birren, B., Nusbaum, C., Zody, M.C., Baldwin, J., Devon, K., Dewar, K., Doyle, M., FitzHugh, W., Funke, R., Gage, D., Harris, K., Heaford, A., Howland, J., Kann, L., Lehoczky, J., LeVine, R., McEwan, P., McKernan, K., Meldrim, J., Mesirov, J.P., Miranda, C., Morris, W., Naylor, J., Raymond, C., Rosetti, M., Santos, R., Sheridan, A., Sougnez, C., Stange-Thomann, N., Stojanovic, N., Subramanian, A., Wyman, D., Rogers, J., Sulston, J., Ainscough, R., Beck, S., Bentley, D., Burton, J., Clee, C., Carter, N., Coulson, A.,

Deadman, R., Deloukas, P., Dunham, A., Dunham, I., Durbin, R., French, L., Grafham, D., Gregory, S., Hubbard, T., Humphray, S., Hunt, A., Jones, M., Lloyd, C., McMurray, A., Matthews, L., Mercer, S., Milne, S., Mullikin, J.C., Mungall, A., Plumb, R., Ross, M., Shownkeen, R., Sims, S., Waterston, R.H., Wilson, R.K., Hillier, L.W., McPherson, J.D., Marra, M.A., Mardis, E.R., Fulton, L.A., Chinwalla, A.T., Pepin, K.H., Gish, W.R., Chissoe, S.L., Wendl, M.C., Delehaunty, K.D., Miner, T.L., Delehaunty, A., Kramer, J.B., Cook, L.L., Fulton, R.S., Johnson, D.L., Minx, P.J., Clifton, S.W., Hawkins, T., Branscomb, E., Predki, P., Richardson, P., Wenning, S., Slezak, T., Doggett, N., Cheng, J.F., Olsen, A., Lucas, S., Elkin, C., Uberbacher, E., Frazier, M., Gibbs, R.A., Muzny, D.M., Scherer, S.E., Bouck, J.B., Sodergren, E.J., Worley, K.C., Rives, C.M., Gorrell, J.H., Metzker, M.L., Naylor, S.L., Kucherlapati, R.S., Nelson, D.L., Weinstock, G.M., Sakaki, Y., Fujiyama, A., Hattori, M., Yada, T., Toyoda, A., Itoh, T., Kawagoe, C., Watanabe, H., Totoki, Y., Taylor, T., Weissenbach, J., Heilig, R., Saurin, W., Artiguenave, F., Brottier, P., Bruls, T., Pelletier, E., Robert, C., Wincker, P., Smith, D.R., Doucette-Stamm, L., Rubenfield, M., Weinstock, K., Lee, H.M., Dubois, J., Rosenthal, A., Platzer, M., Nyakatura, G., Taudien, S., Rump, A., Yang, H., Yu, J., Wang, J., Huang, G., Gu, J., Hood, L., Rowen, L., Madan, A., Qin, S., Davis, R.W., Federspiel, N.A., Abola, A.P., Proctor, M.J., Myers, R.M., Schmutz, J., Dickson, M., Grimwood, J., Cox, D.R., Olson, M.V., Kaul, R., Shimizu, N., Kawasaki, K., Minoshima, S., Evans, G.A., Athanasiou, M., Schultz, R., Roe, B.A., Chen, F., Pan, H., Ramser, J., Lehrach, H., Reinhardt, R., McCombie, W.R., de la Bastide, M., Dedhia, N., Blocker, H., Hornischer, K., Nordsiek, G., Agarwala, R., Aravind, L., Bailey, J.A., Bateman, A., Batzoglou, S., Birney, E., Bork, P., Brown, D.G., Burge, C.B., Cerutti, L., Chen, H.C., Church, D., Clamp, M., Copley, R.R., Doerks, T., Eddy, S.R., Eichler, E.E., Furey, T.S., Galagan, J., Gilbert, J.G., Harmon, C., Hayashizaki, Y., Haussler, D., Hermjakob, H., Hokamp, K., Jang, W., Johnson, L.S., Jones, T.A., Kasif, S., Kaspryzk, A., Kennedy, S., Kent, W.J., Kitts, P., Koonin, E.V., Korf, I., Kulp, D., Lancet, D., Lowe, T.M., McLysaght, A., Mikkelsen, T., Moran, J.V., Mulder, N., Pollara, V.J., Ponting, C.P., Schuler, G., Schultz, J., Slater, G., Smit, A.F., Stupka, E., Szustakowski, J., Thierry-Mieg, D., Thierry-Mieg, J., Wagner, L., Wallis, J., Wheeler, R., Williams, A., Wolf, Y.I., Wolfe, K.H., Yang, S.P., Yeh, R.F., Collins, F., Guyer, M.S., Peterson, J., Felsenfeld, A., Wetterstrand, K.A., Patrinos, A.,

- Morgan, M.J., de Jong, P., Catanese, J.J., Osoegawa, K., Shizuya, H., Choi, S. and Chen, Y.J., *Initial sequencing and analysis of the human genome*. Nature 2001; 409(6822): 860-921.
181. Venter, J.C., Adams, M.D., Myers, E.W., Li, P.W., Mural, R.J., Sutton, G.G., Smith, H.O., Yandell, M., Evans, C.A., Holt, R.A., Gocayne, J.D., Amanatides, P., Ballew, R.M., Huson, D.H., Wortman, J.R., Zhang, Q., Kodira, C.D., Zheng, X.H., Chen, L., Skupski, M., Subramanian, G., Thomas, P.D., Zhang, J., Gabor Miklos, G.L., Nelson, C., Broder, S., Clark, A.G., Nadeau, J., McKusick, V.A., Zinder, N., Levine, A.J., Roberts, R.J., Simon, M., Slayman, C., Hunkapiller, M., Bolanos, R., Delcher, A., Dew, I., Fasulo, D., Flanigan, M., Florea, L., Halpern, A., Hannenhalli, S., Kravitz, S., Levy, S., Mobarry, C., Reinert, K., Remington, K., Abu-Threideh, J., Beasley, E., Biddick, K., Bonazzi, V., Brandon, R., Cargill, M., Chandramouliwaran, I., Charlab, R., Chaturvedi, K., Deng, Z., Di Francesco, V., Dunn, P., Eilbeck, K., Evangelista, C., Gabrielian, A.E., Gan, W., Ge, W., Gong, F., Gu, Z., Guan, P., Heiman, T.J., Higgins, M.E., Ji, R.R., Ke, Z., Ketchum, K.A., Lai, Z., Lei, Y., Li, Z., Li, J., Liang, Y., Lin, X., Lu, F., Merkulov, G.V., Milshina, N., Moore, H.M., Naik, A.K., Narayan, V.A., Neelam, B., Nusskern, D., Rusch, D.B., Salzberg, S., Shao, W., Shue, B., Sun, J., Wang, Z., Wang, A., Wang, X., Wang, J., Wei, M., Wides, R., Xiao, C., Yan, C., Yao, A., Ye, J., Zhan, M., Zhang, W., Zhang, H., Zhao, Q., Zheng, L., Zhong, F., Zhong, W., Zhu, S., Zhao, S., Gilbert, D., Baumhueter, S., Spier, G., Carter, C., Cravchik, A., Woodage, T., Ali, F., An, H., Awe, A., Baldwin, D., Baden, H., Barnstead, M., Barrow, I., Beeson, K., Busam, D., Carver, A., Center, A., Cheng, M.L., Curry, L., Danaher, S., Davenport, L., Desilets, R., Dietz, S., Dodson, K., Doucet, L., Ferriera, S., Garg, N., Gluecksmann, A., Hart, B., Haynes, J., Haynes, C., Heiner, C., Hladun, S., Hostin, D., Houck, J., Howland, T., Ibegwam, C., Johnson, J., Kalush, F., Kline, L., Koduru, S., Love, A., Mann, F., May, D., McCawley, S., McIntosh, T., McMullen, I., Moy, M., Moy, L., Murphy, B., Nelson, K., Pfannkoch, C., Pratts, E., Puri, V., Qureshi, H., Reardon, M., Rodriguez, R., Rogers, Y.H., Romblad, D., Ruhfel, B., Scott, R., Sitter, C., Smallwood, M., Stewart, E., Strong, R., Suh, E., Thomas, R., Tint, N.N., Tse, S., Vech, C., Wang, G., Wetter, J., Williams, S., Williams, M., Windsor, S., Winn-Deen, E., Wolfe, K., Zaveri, J., Zaveri, K., Abril, J.F., Guigo, R., Campbell, M.J., Sjolander, K.V., Karlak, B., Kejariwal, A., Mi, H., Lazareva, B., Hatton, T., Narechania, A., Diemer, K., Muruganujan, A., Guo, N., Sato, S.,

- Bafna, V., Istrail, S., Lippert, R., Schwartz, R., Walenz, B., Yooseph, S., Allen, D., Basu, A., Baxendale, J., Blick, L., Caminha, M., Carnes-Stine, J., Caulk, P., Chiang, Y.H., Coyne, M., Dahlke, C., Mays, A., Dombroski, M., Donnelly, M., Ely, D., Esparham, S., Fosler, C., Gire, H., Glanowski, S., Glasser, K., Glodek, A., Gorokhov, M., Graham, K., Gropman, B., Harris, M., Heil, J., Henderson, S., Hoover, J., Jennings, D., Jordan, C., Jordan, J., Kasha, J., Kagan, L., Kraft, C., Levitsky, A., Lewis, M., Liu, X., Lopez, J., Ma, D., Majoros, W., McDaniel, J., Murphy, S., Newman, M., Nguyen, T., Nguyen, N., Nodell, M., Pan, S., Peck, J., Peterson, M., Rowe, W., Sanders, R., Scott, J., Simpson, M., Smith, T., Sprague, A., Stockwell, T., Turner, R., Venter, E., Wang, M., Wen, M., Wu, D., Wu, M., Xia, A., Zandieh, A. and Zhu, X., *The sequence of the human genome*. Science 2001; 291(5507): 1304-51.
182. Wright, G.W. and Simon, R.M., *A random variance model for detection of differential gene expression in small microarray experiments*. Bioinformatics 2003; 19(18): 2448-55.
183. Kallioniemi, O.P., Wagner, U., Kononen, J., and Sauter, G., *Tissue microarray technology for high-throughput molecular profiling of cancer*. Hum Mol Genet 2001; 10(7): 657-62.
184. Han, E. and Hilsenbeck, S.G., *Array-based gene expression profiling to study aging*. Mech Ageing Dev 2001; 122(10): 999-1018.
185. Takikita, M., Chung, J.Y., and Hewitt, S.M., *Tissue microarrays enabling high-throughput molecular pathology*. Curr Opin Biotechnol 2007; 18(4): 318-25.
186. Simon, R., *Microarray-based expression profiling and informatics*. Curr Opin Biotechnol 2008; 19(1): 26-9.
187. Zaidi, M., *Skeletal remodeling in health and disease*. Nat Med 2007; 13(7): 791-801.
188. Lian, J.B., Stein, G.S., Javed, A., van Wijnen, A.J., Stein, J.L., Montecino, M., Hassan, M.Q., Gaur, T., Lengner, C.J., and Young, D.W., *Networks and hubs for the transcriptional control of osteoblastogenesis*. Rev Endocr Metab Disord 2006; 7(1-2): 1-16.
189. Romero-Prado, M., Blazquez, C., Rodriguez-Navas, C., Munoz, J., Guerrero, I., Delgado-Baeza, E., and Garcia-Ruiz, J.P., *Functional characterization of human mesenchymal stem cells that maintain osteochondral fates*. J Cell Biochem 2006; 98(6): 1457-70.

190. Komori, T., *Regulation of osteoblast differentiation by transcription factors.* J Cell Biochem 2006; 99(5): 1233-9.
191. Kulterer, B., Friedl, G., Jandrositz, A., Sanchez-Cabo, F., Prokesch, A., Paar, C., Scheideler, M., Windhager, R., Preisegger, K.H., and Trajanoski, Z., *Gene expression profiling of human mesenchymal stem cells derived from bone marrow during expansion and osteoblast differentiation.* BMC Genomics 2007; 8: 70.
192. Ruzinova, M.B. and Benezra, R., *Id proteins in development, cell cycle and cancer.* Trends Cell Biol 2003; 13(8): 410-8.
193. Norton, J.D., *ID helix-loop-helix proteins in cell growth, differentiation and tumorigenesis.* J Cell Sci 2000; 113 ( Pt 22): 3897-905.
194. Benezra, R., Davis, R.L., Lockshon, D., Turner, D.L., and Weintraub, H., *The protein Id: a negative regulator of helix-loop-helix DNA binding proteins.* Cell 1990; 61(1): 49-59.
195. Pagliuca, A., Cannada-Bartoli, P., and Lania, L., *A role for Sp and helix-loop-helix transcription factors in the regulation of the human Id4 gene promoter activity.* J Biol Chem 1998; 273(13): 7668-74.
196. Furushima, K., Shimo-Onoda, K., Maeda, S., Nobukuni, T., Ikari, K., Koga, H., Komiya, S., Nakajima, T., Harata, S., and Inoue, I., *Large-scale screening for candidate genes of ossification of the posterior longitudinal ligament of the spine.* J Bone Miner Res 2002; 17(1): 128-37.
197. Petersen, C.M., Nielsen, M.S., Nykjaer, A., Jacobsen, L., Tommerup, N., Rasmussen, H.H., Roigaard, H., Gliemann, J., Madsen, P., and Moestrup, S.K., *Molecular identification of a novel candidate sorting receptor purified from human brain by receptor-associated protein affinity chromatography.* J Biol Chem 1997; 272(6): 3599-605.
198. Nohe, A., Hassel, S., Ehrlich, M., Neubauer, F., Sebald, W., Henis, Y.I., and Knaus, P., *The mode of bone morphogenetic protein (BMP) receptor oligomerization determines different BMP-2 signaling pathways.* J Biol Chem 2002; 277(7): 5330-8.
199. Maeda, S., Nobukuni, T., Shimo-Onoda, K., Hayashi, K., Yone, K., Komiya, S., and Inoue, I., *Sortilin is upregulated during osteoblastic differentiation of mesenchymal stem cells and promotes extracellular matrix mineralization.* J Cell Physiol 2002; 193(1): 73-9.

200. Pochampally, R.R., Ylostalo, J., Penfornis, P., Matz, R.R., Smith, J.R., and Prockop, D.J., *Histamine receptor H1 and dermatopontin: new downstream targets of the vitamin D receptor.* J Bone Miner Res 2007; 22(9): 1338-49.
201. Christakos, S., Dhawan, P., Liu, Y., Peng, X., and Porta, A., *New insights into the mechanisms of vitamin D action.* J Cell Biochem 2003; 88(4): 695-705.
202. Weiss, L., *The hematopoietic microenvironment of the bone marrow: an ultrastructural study of the stroma in rats.* Anat Rec 1976; 186(2): 161-84.
203. Lichtman, M.A., *The ultrastructure of the hemopoietic environment of the marrow: a review.* Exp Hematol 1981; 9(4): 391-410.
204. Tavassoli, M. and Friedenstein, A., *Hemopoietic stromal microenvironment.* Am J Hematol 1983; 15(2): 195-203.
205. Bianco, P. and Gehron Robey, P., *Marrow stromal stem cells.* J Clin Invest 2000; 105(12): 1663-8.
206. Hung, S.C., Chang, C.F., Ma, H.L., Chen, T.H., and Low-Tone Ho, L., *Gene expression profiles of early adipogenesis in human mesenchymal stem cells.* Gene 2004; 340(1): 141-50.
207. Shugart, E.C., Levenson, A.S., Constance, C.M., and Umek, R.M., *Differential expression of gas and gadd genes at distinct growth arrest points during adipocyte development.* Cell Growth Differ 1995; 6(12): 1541-7.
208. Alexander, D.L., Ganem, L.G., Fernandez-Salguero, P., Gonzalez, F., and Jefcoate, C.R., *Aryl-hydrocarbon receptor is an inhibitory regulator of lipid synthesis and of commitment to adipogenesis.* J Cell Sci 1998; 111 ( Pt 22): 3311-22.
209. Liu, Z., Chang, G.Q., and Leibowitz, S.F., *Apolipoprotein D interacts with the long-form leptin receptor: a hypothalamic function in the control of energy homeostasis.* FASEB J 2001; 15(7): 1329-31.
210. White, J.M., *ADAMs: modulators of cell-cell and cell-matrix interactions.* Curr Opin Cell Biol 2003; 15(5): 598-606.
211. Sandy, J.D., Westling, J., Kenagy, R.D., Iruela-Arispe, M.L., Verscharen, C., Rodriguez-Mazaneque, J.C., Zimmermann, D.R., Lemire, J.M., Fischer, J.W., Wight, T.N., and Clowes, A.W., *Versican VI proteolysis in human aorta in vivo occurs at the Glu441-Ala442 bond, a site that is cleaved by recombinant ADAMTS-1 and ADAMTS-4.* J Biol Chem 2001; 276(16): 13372-8.

212. Carlberg, A.L., Pucci, B., Rallapalli, R., Tuan, R.S., and Hall, D.J., *Efficient chondrogenic differentiation of mesenchymal cells in micromass culture by retroviral gene transfer of BMP-2*. Differentiation 2001; 67(4-5): 128-38.
213. Djouad, F., Delorme, B., Maurice, M., Bony, C., Apparailly, F., Louis-Plence, P., Canovas, F., Charbord, P., Noel, D., and Jorgensen, C., *Microenvironmental changes during differentiation of mesenchymal stem cells towards chondrocytes*. Arthritis Res Ther 2007; 9(2): R33.
214. Goessler, U.R., Bieback, K., Bugert, P., Heller, T., Sadick, H., Hormann, K., and Riedel, F., *In vitro analysis of integrin expression during chondrogenic differentiation of mesenchymal stem cells and chondrocytes upon dedifferentiation in cell culture*. Int J Mol Med 2006; 17(2): 301-7.
215. Goessler, U.R., Bugert, P., Bieback, K., Huber, K., Fleischer, L.I., Hormann, K., and Riedel, F., *Differential modulation of integrin expression in chondrocytes during expansion for tissue engineering*. In Vivo 2005; 19(3): 501-7.
216. Loeser, R.F., Carlson, C.S., and McGee, M.P., *Expression of beta 1 integrins by cultured articular chondrocytes and in osteoarthritic cartilage*. Exp Cell Res 1995; 217(2): 248-57.
217. Makihira, S., Yan, W., Murakami, H., Furukawa, M., Kawai, T., Nikawa, H., Yoshida, E., Hamada, T., Okada, Y., and Kato, Y., *Thyroid hormone enhances aggrecanase-2/ADAM-TS5 expression and proteoglycan degradation in growth plate cartilage*. Endocrinology 2003; 144(6): 2480-8.
218. Tamamura, Y., Otani, T., Kanatani, N., Koyama, E., Kitagaki, J., Komori, T., Yamada, Y., Costantini, F., Wakisaka, S., Pacifici, M., Iwamoto, M., and Enomoto-Iwamoto, M., *Developmental regulation of Wnt/beta-catenin signals is required for growth plate assembly, cartilage integrity, and endochondral ossification*. J Biol Chem 2005; 280(19): 19185-95.
219. Parisi, M.S., Gazzero, E., Rydziel, S., and Canalis, E., *Expression and regulation of CCN genes in murine osteoblasts*. Bone 2006; 38(5): 671-7.
220. Lake, A.C., Bialik, A., Walsh, K., and Castellot, J.J., Jr., *CCN5 is a growth arrest-specific gene that regulates smooth muscle cell proliferation and motility*. Am J Pathol 2003; 162(1): 219-31.
221. Goessler, U.R., Bugert, P., Bieback, K., Deml, M., Sadick, H., Hormann, K., and Riedel, F., *In-vitro analysis of the expression of TGFbeta -superfamily-members*

- during chondrogenic differentiation of mesenchymal stem cells and chondrocytes during dedifferentiation in cell culture.* Cell Mol Biol Lett 2005; 10(2): 345-62.
222. Liu, T.M., Martina, M., Hutmacher, D.W., Hui, J.H., Lee, E.H., and Lim, B., *Identification of common pathways mediating differentiation of bone marrow- and adipose tissue-derived human mesenchymal stem cells into three mesenchymal lineages.* Stem Cells 2007; 25(3): 750-60.
223. Ikeda, R., Yoshida, K., Tsukahara, S., Sakamoto, Y., Tanaka, H., Furukawa, K., and Inoue, I., *The promyelotic leukemia zinc finger promotes osteoblastic differentiation of human mesenchymal stem cells as an upstream regulator of CBFA1.* J Biol Chem 2005; 280(9): 8523-30.
224. Hubler, T.R., Denny, W.B., Valentine, D.L., Cheung-Flynn, J., Smith, D.F., and Scammell, J.G., *The FK506-binding immunophilin FKBP51 is transcriptionally regulated by progestin and attenuates progestin responsiveness.* Endocrinology 2003; 144(6): 2380-7.
225. Vittorioso, P., Cowling, R., Faure, J.D., Caboche, M., and Bellini, C., *Mutation in the Arabidopsis PASTICCINO1 gene, which encodes a new FK506-binding protein-like protein, has a dramatic effect on plant development.* Mol Cell Biol 1998; 18(5): 3034-43.
226. Okamoto, O. and Fujiwara, S., *Dermatopontin, a novel player in the biology of the extracellular matrix.* Connect Tissue Res 2006; 47(4): 177-89.
227. Tsai, M.S., Hwang, S.M., Chen, K.D., Lee, Y.S., Hsu, L.W., Chang, Y.J., Wang, C.N., Peng, H.H., Chang, Y.L., Chao, A.S., Chang, S.D., Lee, K.D., Wang, T.H., Wang, H.S., and Soong, Y.K., *Functional network analysis of the transcriptomes of mesenchymal stem cells derived from amniotic fluid, amniotic membrane, cord blood, and bone marrow.* Stem Cells 2007; 25(10): 2511-23.
228. Gronthos, S. and Zannettino, A.C., *A method to isolate and purify human bone marrow stromal stem cells.* Methods Mol Biol 2008; 449: 45-57.
229. Gimble, J.M., *Marrow stromal adipocytes.* In Marrow stromal cell culture., ed. Beresford, J.N. and Owen, M. 1998, Cambridge: Cambridge University Press.
230. Isenmann, S., Arthur, A., Zannettino, A.C., Turner, J.L., Shi, S., Glackin, C.A., and Gronthos, S., *TWIST family of basic Helix-Loop-Helix Transcription Factors Mediate Human Mesenchymal Stromal/Stem Cell Growth and Commitment.* Stem Cells 2009.

231. Filshie, R.J., Zannettino, A.C., Makrynikola, V., Gronthos, S., Henniker, A.J., Bendall, L.J., Gottlieb, D.J., Simmons, P.J., and Bradstock, K.F., *MUC18, a member of the immunoglobulin superfamily, is expressed on bone marrow fibroblasts and a subset of hematological malignancies.* Leukemia 1998; 12(3): 414-21.
232. Du, P., Kibbe, W.A., and Lin, S.M., *nuid: a universal naming scheme of oligonucleotides for illumina, affymetrix, and other microarrays.* Biol Direct 2007; 2: 16.
233. Lin, S.M., Du, P., Huber, W., and Kibbe, W.A., *Model-based variance-stabilizing transformation for Illumina microarray data.* Nucleic Acids Res 2008; 36(2): e11.
234. Horwitz, E.M. and Keating, A., *Nonhematopoietic mesenchymal stem cells: what are they?* Cytotherapy 2000; 2(5): 387-8.
235. Owen, M.E., Cave, J., and Joyner, C.J., *Clonal analysis in vitro of osteogenic differentiation of marrow CFU-F.* J Cell Sci 1987; 87 ( Pt 5): 731-8.
236. Friedenstein, A.J., *Precursor cells of mechanocytes.* Int Rev Cytol 1976; 47: 327-59.
237. Castro-Malaspina, H., Gay, R.E., Resnick, G., Kapoor, N., Meyers, P., Chiarieri, D., McKenzie, S., Broxmeyer, H.E., and Moore, M.A., *Characterization of human bone marrow fibroblast colony-forming cells (CFU-F) and their progeny.* Blood 1980; 56(2): 289-301.
238. Muraglia, A., Cancedda, R., and Quarto, R., *Clonal mesenchymal progenitors from human bone marrow differentiate in vitro according to a hierarchical model.* J Cell Sci 2000; 113 ( Pt 7): 1161-6.
239. Halleux, C., Sottile, V., Gasser, J.A., and Seuwen, K., *Multi-lineage potential of human mesenchymal stem cells following clonal expansion.* J Musculoskelet Neuronal Interact 2001; 2(1): 71-6.
240. Woodbury, D., Reynolds, K., and Black, I.B., *Adult bone marrow stromal stem cells express germline, ectodermal, endodermal, and mesodermal genes prior to neurogenesis.* J Neurosci Res 2002; 69(6): 908-17.
241. Okamoto, T., Aoyama, T., Nakayama, T., Nakamata, T., Hosaka, T., Nishijo, K., Nakamura, T., Kiyono, T., and Toguchida, J., *Clonal heterogeneity in differentiation potential of immortalized human mesenchymal stem cells.* Biochem Biophys Res Commun 2002; 295(2): 354-61.

242. Post, S., Abdallah, B.M., Bentzon, J.F., and Kassem, M., *Demonstration of the presence of independent pre-osteoblastic and pre-adipocytic cell populations in bone marrow-derived mesenchymal stem cells*. Bone 2008; 43(1): 32-9.
243. Mareddy, S., Crawford, R., Brooke, G., and Xiao, Y., *Clonal isolation and characterization of bone marrow stromal cells from patients with osteoarthritis*. Tissue Eng 2007; 13(4): 819-29.
244. Mareddy, S., Broadbent, J., Crawford, R., and Xiao, Y., *Proteomic profiling of distinct clonal populations of bone marrow mesenchymal stem cells*. J Cell Biochem 2009; 106(5): 776-86.
245. Xiao, Y., Mareddy, S., Crawford, R., and Dhaliwal, N., *Stem cell related gene expression in clonal populations of mesenchymal stromal cells from bone marrow*. Tissue Eng Part A 2009.
246. Lee, C.C., Christensen, J.E., Yoder, M.C., and Tarantal, A.F., *Clonal analysis and hierarchy of human bone marrow mesenchymal stem and progenitor cells*. Exp Hematol 2009; 38(1): 46-54.
247. Waddington, R.J., Youde, S.J., Lee, C.P., and Sloan, A.J., *Isolation of distinct progenitor stem cell populations from dental pulp*. Cells Tissues Organs 2009; 189(1-4): 268-74.
248. Bartsch, G., Yoo, J.J., De Coppi, P., Siddiqui, M.M., Schuch, G., Pohl, H.G., Fuhr, J., Perin, L., Soker, S., and Atala, A., *Propagation, expansion, and multilineage differentiation of human somatic stem cells from dermal progenitors*. Stem Cells Dev 2005; 14(3): 337-48.
249. Karystinou, A., Dell'Accio, F., Kurth, T.B., Wackerhage, H., Khan, I.M., Archer, C.W., Jones, E.A., Mitsiadis, T.A., and De Bari, C., *Distinct mesenchymal progenitor cell subsets in the adult human synovium*. Rheumatology (Oxford) 2009; 48(9): 1057-64.
250. De Bari, C., Dell'Accio, F., Vanlauwe, J., Eyckmans, J., Khan, I.M., Archer, C.W., Jones, E.A., McGonagle, D., Mitsiadis, T.A., Pitzalis, C., and Luyten, F.P., *Mesenchymal multipotency of adult human periosteal cells demonstrated by single-cell lineage analysis*. Arthritis Rheum 2006; 54(4): 1209-21.
251. Psaltis, P.J., Paton, S., See, F., Arthur, A., Martin, S., Itescu, S., Worthley, S.G., Gronthos, S., and Zannettino, A.C., *Enrichment for STRO-1 expression enhances the cardiovascular paracrine activity of human bone marrow-derived mesenchymal cell populations*. J Cell Physiol 223(2): 530-40.

252. Huang, G.T., Gronthos, S., and Shi, S., *Mesenchymal stem cells derived from dental tissues vs. those from other sources: their biology and role in regenerative medicine.* J Dent Res 2009; 88(9): 792-806.
253. Thesleff, I. and Aberg, T., *Molecular regulation of tooth development.* Bone 1999; 25(1): 123-5.
254. Sakaguchi, Y., Sekiya, I., Yagishita, K., and Muneta, T., *Comparison of human stem cells derived from various mesenchymal tissues: superiority of synovium as a cell source.* Arthritis Rheum 2005; 52(8): 2521-9.
255. Musina, R.A., Bekchanova, E.S., and Sukhikh, G.T., *Comparison of mesenchymal stem cells obtained from different human tissues.* Bull Exp Biol Med 2005; 139(4): 504-9.
256. Suzdal'tseva, Y.G., Burunova, V.V., Vakhrushev, I.V., Yarygin, V.N., and Yarygin, K.N., *Capability of human mesenchymal cells isolated from different sources to differentiation into tissues of mesodermal origin.* Bull Exp Biol Med 2007; 143(1): 114-21.
257. Noel, D., Caton, D., Roche, S., Bony, C., Lehmann, S., Casteilla, L., Jorgensen, C., and Cousin, B., *Cell specific differences between human adipose-derived and mesenchymal-stromal cells despite similar differentiation potentials.* Exp Cell Res 2008; 314(7): 1575-84.
258. Park, H.W., Shin, J.S., and Kim, C.W., *Proteome of mesenchymal stem cells.* Proteomics 2007; 7(16): 2881-94.
259. Afizah, H., Yang, Z., Hui, J.H., Ouyang, H.W., and Lee, E.H., *A comparison between the chondrogenic potential of human bone marrow stem cells (BMSCs) and adipose-derived stem cells (ADSCs) taken from the same donors.* Tissue Eng 2007; 13(4): 659-66.
260. Kawada, H., Fujita, J., Kinjo, K., Matsuzaki, Y., Tsuma, M., Miyatake, H., Muguruma, Y., Tsuboi, K., Itabashi, Y., Ikeda, Y., Ogawa, S., Okano, H., Hotta, T., Ando, K., and Fukuda, K., *Nonhematopoietic mesenchymal stem cells can be mobilized and differentiate into cardiomyocytes after myocardial infarction.* Blood 2004; 104(12): 3581-7.
261. Kopen, G.C., Prockop, D.J., and Phinney, D.G., *Marrow stromal cells migrate throughout forebrain and cerebellum, and they differentiate into astrocytes after injection into neonatal mouse brains.* Proc Natl Acad Sci U S A 1999; 96(19): 10711-6.

262. Gronthos, S., Zannettino, A.C., Graves, S.E., Ohta, S., Hay, S.J., and Simmons, P.J., *Differential cell surface expression of the STRO-1 and alkaline phosphatase antigens on discrete developmental stages in primary cultures of human bone cells.* J Bone Miner Res 1999; 14(1): 47-56.
263. Stewart, K., Walsh, S., Screen, J., Jefferiss, C.M., Chainey, J., Jordan, G.R., and Beresford, J.N., *Further characterization of cells expressing STRO-1 in cultures of adult human bone marrow stromal cells.* J Bone Miner Res 1999; 14(8): 1345-56.
264. Hung, S.C., Chen, N.J., Hsieh, S.L., Li, H., Ma, H.L., and Lo, W.H., *Isolation and characterization of size-sieved stem cells from human bone marrow.* Stem Cells 2002; 20(3): 249-58.
265. Zuk, P.A., Zhu, M., Ashjian, P., De Ugarte, D.A., Huang, J.I., Mizuno, H., Alfonso, Z.C., Fraser, J.K., Benhaim, P., and Hedrick, M.H., *Human adipose tissue is a source of multipotent stem cells.* Mol Biol Cell 2002; 13(12): 4279-95.
266. Gronthos, S., Franklin, D.M., Leddy, H.A., Robey, P.G., Storms, R.W., and Gimble, J.M., *Surface protein characterization of human adipose tissue-derived stromal cells.* J Cell Physiol 2001; 189(1): 54-63.
267. Owen, M. and Friedenstein, A.J., *Stromal stem cells: marrow-derived osteogenic precursors.* Ciba Found Symp 1988; 136: 42-60.
268. Schena, M., Shalon, D., Davis, R.W., and Brown, P.O., *Quantitative monitoring of gene expression patterns with a complementary DNA microarray.* Science 1995; 270(5235): 467-70.
269. Hardiman, G., *Microarray platforms--comparisons and contrasts.* Pharmacogenomics 2004; 5(5): 487-502.
270. Lobenhofer, E.K., Bushel, P.R., Afshari, C.A., and Hamadeh, H.K., *Progress in the application of DNA microarrays.* Environ Health Perspect 2001; 109(9): 881-91.
271. Watson, S.J., Meng, F., Thompson, R.C., and Akil, H., *The "chip" as a specific genetic tool.* Biol Psychiatry 2000; 48(12): 1147-56.
272. Michael, K.L., Taylor, L.C., Schultz, S.L., and Walt, D.R., *Randomly ordered addressable high-density optical sensor arrays.* Anal Chem 1998; 70(7): 1242-8.
273. Barnes, M., Freudenberg, J., Thompson, S., Aronow, B., and Pavlidis, P., *Experimental comparison and cross-validation of the Affymetrix and Illumina gene expression analysis platforms.* Nucleic Acids Res 2005; 33(18): 5914-23.

274. Shi, W., Banerjee, A., Ritchie, M.E., Gerondakis, S., and Smyth, G.K., *Illumina WG-6 BeadChip strips should be normalized separately*. BMC Bioinformatics 2009; 10: 372.
275. Menicanin, D., Bartold, P.M., Zannettino, A.C., and Gronthos, S., *Genomic profiling of mesenchymal stem cells*. Stem Cell Rev 2009; 5(1): 36-50.
276. Akavia, U.D., Veinblat, O., and Benayahu, D., *Comparing the transcriptional profile of mesenchymal cells to cardiac and skeletal muscle cells*. J Cell Physiol 2008; 216(3): 663-72.
277. Cam, H. and Dynlacht, B.D., *Emerging roles for E2F: beyond the G1/S transition and DNA replication*. Cancer Cell 2003; 3(4): 311-6.
278. DeGregori, J., *The genetics of the E2F family of transcription factors: shared functions and unique roles*. Biochim Biophys Acta 2002; 1602(2): 131-50.
279. Stevaux, O. and Dyson, N.J., *A revised picture of the E2F transcriptional network and RB function*. Curr Opin Cell Biol 2002; 14(6): 684-91.
280. Timmers, C., Sharma, N., Opavsky, R., Maiti, B., Wu, L., Wu, J., Orringer, D., Trikha, P., Saavedra, H.I., and Leone, G., *E2f1, E2f2, and E2f3 control E2F target expression and cellular proliferation via a p53-dependent negative feedback loop*. Mol Cell Biol 2007; 27(1): 65-78.
281. Trimarchi, J.M. and Lees, J.A., *Sibling rivalry in the E2F family*. Nat Rev Mol Cell Biol 2002; 3(1): 11-20.
282. Won, J., Yim, J., and Kim, T.K., *Opposing regulatory roles of E2F in human telomerase reverse transcriptase (hTERT) gene expression in human tumor and normal somatic cells*. FASEB J 2002; 16(14): 1943-5.
283. Berletch, J.B., Liu, C., Love, W.K., Andrews, L.G., Katiyar, S.K., and Tollefsbol, T.O., *Epigenetic and genetic mechanisms contribute to telomerase inhibition by EGCG*. J Cell Biochem 2008; 103(2): 509-19.
284. Zakian, V.A., *Telomeres: beginning to understand the end*. Science 1995; 270(5242): 1601-7.
285. Meyerson, M., Counter, C.M., Eaton, E.N., Ellisen, L.W., Steiner, P., Caddle, S.D., Ziaugra, L., Beijersbergen, R.L., Davidoff, M.J., Liu, Q., Bacchetti, S., Haber, D.A., and Weinberg, R.A., *hEST2, the putative human telomerase catalytic subunit gene, is up-regulated in tumor cells and during immortalization*. Cell 1997; 90(4): 785-95.

286. Blasco, M.A., *Telomeres and human disease: ageing, cancer and beyond*. Nat Rev Genet 2005; 6(8): 611-22.
287. Agulnick, A.D., Taira, M., Breen, J.J., Tanaka, T., Dawid, I.B., and Westphal, H., *Interactions of the LIM-domain-binding factor Ldb1 with LIM homeodomain proteins*. Nature 1996; 384(6606): 270-2.
288. Infante, A., Laresgoiti, U., Fernandez-Rueda, J., Fullaondo, A., Galan, J., Diaz-Uriarte, R., Malumbres, M., Field, S.J., and Zubiaga, A.M., *E2F2 represses cell cycle regulators to maintain quiescence*. Cell Cycle 2008; 7(24): 3915-27.
289. Murga, M., Fernandez-Capelllo, O., Field, S.J., Moreno, B., Borlado, L.R., Fujiwara, Y., Balomenos, D., Vicario, A., Carrera, A.C., Orkin, S.H., Greenberg, M.E., and Zubiaga, A.M., *Mutation of E2F2 in mice causes enhanced T lymphocyte proliferation, leading to the development of autoimmunity*. Immunity 2001; 15(6): 959-70.
290. Zhu, J.W., Field, S.J., Gore, L., Thompson, M., Yang, H., Fujiwara, Y., Cardiff, R.D., Greenberg, M., Orkin, S.H., and DeGregori, J., *E2F1 and E2F2 determine thresholds for antigen-induced T-cell proliferation and suppress tumorigenesis*. Mol Cell Biol 2001; 21(24): 8547-64.
291. Iglesias, A., Murga, M., Laresgoiti, U., Skoudy, A., Bernales, I., Fullaondo, A., Moreno, B., Lloreta, J., Field, S.J., Real, F.X., and Zubiaga, A.M., *Diabetes and exocrine pancreatic insufficiency in E2F1/E2F2 double-mutant mice*. J Clin Invest 2004; 113(10): 1398-407.
292. Persengiev, S.P., Li, J., Poulin, M.L., and Kilpatrick, D.L., *E2F2 converts reversibly differentiated PC12 cells to an irreversible, neurotrophin-dependent state*. Oncogene 2001; 20(37): 5124-31.
293. Dirlam, A., Spike, B.T., and Macleod, K.F., *Deregulated E2f-2 underlies cell cycle and maturation defects in retinoblastoma null erythroblasts*. Mol Cell Biol 2007; 27(24): 8713-28.
294. Ebelt, H., Zhang, Y., Kampke, A., Xu, J., Schlitt, A., Buerke, M., Muller-Werdan, U., Werdan, K., and Braun, T., *E2F2 expression induces proliferation of terminally differentiated cardiomyocytes in vivo*. Cardiovasc Res 2008; 80(2): 219-26.
295. Dawid, I.B., *LIM protein interactions: Drosophila enters the stage*. Trends Genet 1998; 14(12): 480-2.
296. Kadomas, J.L. and Beckerle, M.C., *The LIM domain: from the cytoskeleton to the nucleus*. Nat Rev Mol Cell Biol 2004; 5(11): 920-31.

297. Xu, X., Mannik, J., Kudryavtseva, E., Lin, K.K., Flanagan, L.A., Spencer, J., Soto, A., Wang, N., Lu, Z., Yu, Z., Monuki, E.S., and Andersen, B., *Co-factors of LIM domains (Clims/Ldb/Nli) regulate corneal homeostasis and maintenance of hair follicle stem cells.* Dev Biol 2007; 312(2): 484-500.
298. Tran, Y.H., Xu, Z., Kato, A., Mistry, A.C., Goya, Y., Taira, M., Brandt, S.J., and Hirose, S., *Spliced isoforms of LIM-domain-binding protein (CLIM/NLI/Ldb) lacking the LIM-interaction domain.* J Biochem 2006; 140(1): 105-19.
299. Bach, I., *The LIM domain: regulation by association.* Mech Dev 2000; 91(1-2): 5-17.
300. Sanchez-Garcia, I. and Rabitts, T.H., *The LIM domain: a new structural motif found in zinc-finger-like proteins.* Trends Genet 1994; 10(9): 315-20.
301. Hobert, O. and Westphal, H., *Functions of LIM-homeobox genes.* Trends Genet 2000; 16(2): 75-83.
302. Warren, A.J., Colledge, W.H., Carlton, M.B., Evans, M.J., Smith, A.J., and Rabitts, T.H., *The oncogenic cysteine-rich LIM domain protein rbtn2 is essential for erythroid development.* Cell 1994; 78(1): 45-57.
303. Bach, I., Carriere, C., Ostendorff, H.P., Andersen, B., and Rosenfeld, M.G., *A family of LIM domain-associated cofactors confer transcriptional synergism between LIM and Otx homeodomain proteins.* Genes Dev 1997; 11(11): 1370-80.
304. Jurata, L.W., Kenny, D.A., and Gill, G.N., *Nuclear LIM interactor, a rhombotin and LIM homeodomain interacting protein, is expressed early in neuronal development.* Proc Natl Acad Sci U S A 1996; 93(21): 11693-8.
305. Visvader, J.E., Mao, X., Fujiwara, Y., Hahm, K., and Orkin, S.H., *The LIM-domain binding protein Ldb1 and its partner LMO2 act as negative regulators of erythroid differentiation.* Proc Natl Acad Sci U S A 1997; 94(25): 13707-12.
306. Ostendorff, H.P., Peirano, R.I., Peters, M.A., Schluter, A., Bossenz, M., Scheffner, M., and Bach, I., *Ubiquitination-dependent cofactor exchange on LIM homeodomain transcription factors.* Nature 2002; 416(6876): 99-103.
307. Bach, I., Rodriguez-Esteban, C., Carriere, C., Bhushan, A., Krones, A., Rose, D.W., Glass, C.K., Andersen, B., Izpisua Belmonte, J.C., and Rosenfeld, M.G., *RLIM inhibits functional activity of LIM homeodomain transcription factors via recruitment of the histone deacetylase complex.* Nat Genet 1999; 22(4): 394-9.

308. Milan, M. and Cohen, S.M., *Regulation of LIM homeodomain activity in vivo: a tetramer of dLDB and apterous confers activity and capacity for regulation by dLMO*. Mol Cell 1999; 4(2): 267-73.
309. Morcillo, P., Rosen, C., Baylies, M.K., and Dorsett, D., *Chip, a widely expressed chromosomal protein required for segmentation and activity of a remote wing margin enhancer in Drosophila*. Genes Dev 1997; 11(20): 2729-40.
310. van Meyel, D.J., O'Keefe, D.D., Jurata, L.W., Thor, S., Gill, G.N., and Thomas, J.B., *Chip and apterous physically interact to form a functional complex during Drosophila development*. Mol Cell 1999; 4(2): 259-65.
311. van Meyel, D.J., O'Keefe, D.D., Thor, S., Jurata, L.W., Gill, G.N., and Thomas, J.B., *Chip is an essential cofactor for apterous in the regulation of axon guidance in Drosophila*. Development 2000; 127(9): 1823-31.
312. Ostendorff, H.P., Tursun, B., Cornils, K., Schluter, A., Drung, A., Gungor, C., and Bach, I., *Dynamic expression of LIM cofactors in the developing mouse neural tube*. Dev Dyn 2006; 235(3): 786-91.
313. Fassunke, J., Majores, M., Tresch, A., Niehusmann, P., Grote, A., Schoch, S., and Becker, A.J., *Array analysis of epilepsy-associated gangliogliomas reveals expression patterns related to aberrant development of neuronal precursors*. Brain 2008; 131(Pt 11): 3034-50.
314. Thaler, J.P., Lee, S.K., Jurata, L.W., Gill, G.N., and Pfaff, S.L., *LIM factor Lhx3 contributes to the specification of motor neuron and interneuron identity through cell-type-specific protein-protein interactions*. Cell 2002; 110(2): 237-49.
315. Matthews, J.M. and Visvader, J.E., *LIM-domain-binding protein 1: a multifunctional cofactor that interacts with diverse proteins*. EMBO Rep 2003; 4(12): 1132-7.
316. Pei, L. and Melmed, S., *Isolation and characterization of a pituitary tumor-transforming gene (PTTG)*. Mol Endocrinol 1997; 11(4): 433-41.
317. Zou, H., McGarry, T.J., Bernal, T., and Kirschner, M.W., *Identification of a vertebrate sister-chromatid separation inhibitor involved in transformation and tumorigenesis*. Science 1999; 285(5426): 418-22.
318. Jallepalli, P.V., Waizenegger, I.C., Bunz, F., Langer, S., Speicher, M.R., Peters, J.M., Kinzler, K.W., Vogelstein, B., and Lengauer, C., *Securin is required for chromosomal stability in human cells*. Cell 2001; 105(4): 445-57.

319. Ramos-Morales, F., Dominguez, A., Romero, F., Luna, R., Multon, M.C., Pintor-Toro, J.A., and Tortolero, M., *Cell cycle regulated expression and phosphorylation of hpttg proto-oncogene product*. Oncogene 2000; 19(3): 403-9.
320. Romero, F., Multon, M.C., Ramos-Morales, F., Dominguez, A., Bernal, J.A., Pintor-Toro, J.A., and Tortolero, M., *Human securin, hPTTG, is associated with Ku heterodimer, the regulatory subunit of the DNA-dependent protein kinase*. Nucleic Acids Res 2001; 29(6): 1300-7.
321. Chamaon, K., Kirches, E., Kanakis, D., Braeuninger, S., Dietzmann, K., and Mawrin, C., *Regulation of the pituitary tumor transforming gene by insulin-like-growth factor-I and insulin differs between malignant and non-neoplastic astrocytes*. Biochem Biophys Res Commun 2005; 331(1): 86-92.
322. Heaney, A.P., Nelson, V., Fernando, M., and Horwitz, G., *Transforming events in thyroid tumorigenesis and their association with follicular lesions*. J Clin Endocrinol Metab 2001; 86(10): 5025-32.
323. Heaney, A.P., Singson, R., McCabe, C.J., Nelson, V., Nakashima, M., and Melmed, S., *Expression of pituitary-tumour transforming gene in colorectal tumours*. Lancet 2000; 355(9205): 716-9.
324. Kakar, S.S. and Malik, M.T., *Suppression of lung cancer with siRNA targeting PTTG*. Int J Oncol 2006; 29(2): 387-95.
325. Puri, R., Tousson, A., Chen, L., and Kakar, S.S., *Molecular cloning of pituitary tumor transforming gene 1 from ovarian tumors and its expression in tumors*. Cancer Lett 2001; 163(1): 131-9.
326. Solbach, C., Roller, M., Fellbaum, C., Nicoletti, M., and Kaufmann, M., *PTTG mRNA expression in primary breast cancer: a prognostic marker for lymph node invasion and tumor recurrence*. Breast 2004; 13(1): 80-1.
327. Tsai, S.J., Lin, S.J., Cheng, Y.M., Chen, H.M., and Wing, L.Y., *Expression and functional analysis of pituitary tumor transforming gene-1 [corrected] in uterine leiomyomas*. J Clin Endocrinol Metab 2005; 90(6): 3715-23.
328. Zhang, X., Horwitz, G.A., Heaney, A.P., Nakashima, M., Prezant, T.R., Bronstein, M.D., and Melmed, S., *Pituitary tumor transforming gene (PTTG) expression in pituitary adenomas*. J Clin Endocrinol Metab 1999; 84(2): 761-7.
329. Pei, L., *Identification of c-myc as a down-stream target for pituitary tumor-transforming gene*. J Biol Chem 2001; 276(11): 8484-91.

330. Vlotides, G., Eigler, T., and Melmed, S., *Pituitary tumor-transforming gene: physiology and implications for tumorigenesis*. Endocr Rev 2007; 28(2): 165-86.
331. Mei, J., Huang, X., and Zhang, P., *Securin is not required for cellular viability, but is required for normal growth of mouse embryonic fibroblasts*. Curr Biol 2001; 11(15): 1197-201.
332. Rubinek, T., Chesnokova, V., Wolf, I., Wawrowsky, K., Vlotides, G., and Melmed, S., *Discordant proliferation and differentiation in pituitary tumor-transforming gene-null bone marrow stem cells*. Am J Physiol Cell Physiol 2007; 293(3): C1082-92.
333. Chen, Z.F. and Behringer, R.R., *twist is required in head mesenchyme for cranial neural tube morphogenesis*. Genes Dev 1995; 9(6): 686-99.
334. Lee, M.S., Lowe, G.N., Strong, D.D., Wergedal, J.E., and Glackin, C.A., *TWIST, a basic helix-loop-helix transcription factor, can regulate the human osteogenic lineage*. J Cell Biochem 1999; 75(4): 566-77.
335. Leptin, M., *twist and snail as positive and negative regulators during Drosophila mesoderm development*. Genes Dev 1991; 5(9): 1568-76.
336. Lee, M.S., Lowe, G., Flanagan, S., Kuchler, K., and Glackin, C.A., *Human Dermo-1 has attributes similar to twist in early bone development*. Bone 2000; 27(5): 591-602.
337. Burgess, R., Rawls, A., Brown, D., Bradley, A., and Olson, E.N., *Requirement of the paraxis gene for somite formation and musculoskeletal patterning*. Nature 1996; 384(6609): 570-3.
338. Cserjesi, P., Brown, D., Ligon, K.L., Lyons, G.E., Copeland, N.G., Gilbert, D.J., Jenkins, N.A., and Olson, E.N., *Scleraxis: a basic helix-loop-helix protein that prefigures skeletal formation during mouse embryogenesis*. Development 1995; 121(4): 1099-110.
339. Alborzi, A., Mac, K., Glackin, C.A., Murray, S.S., and Zernik, J.H., *Endochondral and intramembranous fetal bone development: osteoblastic cell proliferation, and expression of alkaline phosphatase, m-twist, and histone H4*. J Craniofac Genet Dev Biol 1996; 16(2): 94-106.
340. Connerney, J., Andreeva, V., Leshem, Y., Muentener, C., Mercado, M.A., and Spicer, D.B., *Twist1 dimer selection regulates cranial suture patterning and fusion*. Dev Dyn 2006; 235(5): 1345-57.

341. Rice, D.P., Aberg, T., Chan, Y., Tang, Z., Kettunen, P.J., Pakarinen, L., Maxson, R.E., and Thesleff, I., *Integration of FGF and TWIST in calvarial bone and suture development*. Development 2000; 127(9): 1845-55.
342. Bialek, P., Kern, B., Yang, X., Schrock, M., Sosic, D., Hong, N., Wu, H., Yu, K., Ornitz, D.M., Olson, E.N., Justice, M.J., and Karsenty, G., *A twist code determines the onset of osteoblast differentiation*. Dev Cell 2004; 6(3): 423-35.
343. Kronenberg, H.M., *Twist genes regulate Runx2 and bone formation*. Dev Cell 2004; 6(3): 317-8.
344. Rice, D.P., Rice, R., and Thesleff, I., *Molecular mechanisms in calvarial bone and suture development, and their relation to craniosynostosis*. Eur J Orthod 2003; 25(2): 139-48.
345. Funato, N., Ohtani, K., Ohyama, K., Kuroda, T., and Nakamura, M., *Common regulation of growth arrest and differentiation of osteoblasts by helix-loop-helix factors*. Mol Cell Biol 2001; 21(21): 7416-28.
346. Murray, S.S., Glackin, C.A., Winters, K.A., Gazit, D., Kahn, A.J., and Murray, E.J., *Expression of helix-loop-helix regulatory genes during differentiation of mouse osteoblastic cells*. J Bone Miner Res 1992; 7(10): 1131-8.
347. Tamura, M. and Noda, M., *Identification of DERMO-1 as a member of helix-loop-helix type transcription factors expressed in osteoblastic cells*. J Cell Biochem 1999; 72(2): 167-76.
348. Simpson, P., *Maternal-Zygotic Gene Interactions during Formation of the Dorsoventral Pattern in Drosophila Embryos*. Genetics 1983; 105(3): 615-632.
349. Thisse, B., el Messal, M., and Perrin-Schmitt, F., *The twist gene: isolation of a Drosophila zygotic gene necessary for the establishment of dorsoventral pattern*. Nucleic Acids Res 1987; 15(8): 3439-53.
350. Murre, C., McCaw, P.S., Vaessin, H., Caudy, M., Jan, L.Y., Jan, Y.N., Cabrera, C.V., Buskin, J.N., Hauschka, S.D., Lassar, A.B., and et al., *Interactions between heterologous helix-loop-helix proteins generate complexes that bind specifically to a common DNA sequence*. Cell 1989; 58(3): 537-44.
351. Rose, C.S. and Malcolm, S., *A TWIST in development*. Trends Genet 1997; 13(10): 384-7.
352. Jabs, E.W., *A TWIST in the fate of human osteoblasts identifies signaling molecules involved in skull development*. J Clin Invest 2001; 107(9): 1075-7.

353. Fuchtbauer, E.M., *Expression of M-twist during postimplantation development of the mouse*. Dev Dyn 1995; 204(3): 316-22.
354. Bourgeois, P., Bolcato-Bellemin, A.L., Danse, J.M., Bloch-Zupan, A., Yoshioka, K., Stoetzel, C., and Perrin-Schmitt, F., *The variable expressivity and incomplete penetrance of the twist-null heterozygous mouse phenotype resemble those of human Saethre-Chotzen syndrome*. Hum Mol Genet 1998; 7(6): 945-57.
355. Howard, T.D., Paznekas, W.A., Green, E.D., Chiang, L.C., Ma, N., Ortiz de Luna, R.I., Garcia Delgado, C., Gonzalez-Ramos, M., Kline, A.D., and Jabs, E.W., *Mutations in TWIST, a basic helix-loop-helix transcription factor, in Saethre-Chotzen syndrome*. Nat Genet 1997; 15(1): 36-41.
356. Pantke, O.A., Cohen, M.M., Jr., Witkop, C.J., Jr., Feingold, M., Schaumann, B., Pantke, H.C., and Gorlin, R.J., *The Saethre-Chotzen syndrome*. Birth Defects Orig Artic Ser 1975; 11(2): 190-225.
357. Renier, D., Sainte-Rose, C., Marchac, D., and Hirsch, J.F., *Intracranial pressure in craniostenosis*. J Neurosurg 1982; 57(3): 370-7.
358. David, L.R., Wilson, J.A., Watson, N.E., and Argenta, L.C., *Cerebral perfusion defects secondary to simple craniosynostosis*. J Craniofac Surg 1996; 7(3): 177-85.
359. Gosain, A.K., McCarthy, J.G., and Wisoff, J.H., *Morbidity associated with increased intracranial pressure in Apert and Pfeiffer syndromes: the need for long-term evaluation*. Plast Reconstr Surg 1996; 97(2): 292-301.
360. Gonzalez, S., Hayward, R., Jones, B., and Lane, R., *Upper airway obstruction and raised intracranial pressure in children with craniosynostosis*. Eur Respir J 1997; 10(2): 367-75.
361. Goho, C., *Dental findings in Saethre-Chotzen syndrome (acrocephalosyndactyly type III): report of case*. ASDC J Dent Child 1998; 65(2): 136-7.
362. De Coster, P.J., Mortier, G., Marks, L.A., and Martens, L.C., *Cranial suture biology and dental development: genetic and clinical perspectives*. J Oral Pathol Med 2007; 36(8): 447-55.
363. Woods, R.H., Ul-Haq, E., Wilkie, A.O., Jayamohan, J., Richards, P.G., Johnson, D., Lester, T., and Wall, S.A., *Reoperation for intracranial hypertension in TWIST1-confirmed Saethre-Chotzen syndrome: a 15-year review*. Plast Reconstr Surg 2009; 123(6): 1801-10.
364. Hebrok, M., Wertz, K., and Fuchtbauer, E.M., *M-twist is an inhibitor of muscle differentiation*. Dev Biol 1994; 165(2): 537-44.

365. Spicer, D.B., Rhee, J., Cheung, W.L., and Lassar, A.B., *Inhibition of myogenic bHLH and MEF2 transcription factors by the bHLH protein Twist*. Science 1996; 272(5267): 1476-80.
366. Galler, K.M., Yasue, A., Cavender, A.C., Bialek, P., Karsenty, G., and D'Souza, R.N., *A novel role for Twist-1 in pulp homeostasis*. J Dent Res 2007; 86(10): 951-5.
367. Degistirici, O., Jaquierey, C., Schonebeck, B., Siemonsmeier, J., Gotz, W., Martin, I., and Thie, M., *Defining properties of neural crest-derived progenitor cells from the apex of human developing tooth*. Tissue Eng Part A 2008; 14(2): 317-30.
368. Komaki, M., Karakida, T., Abe, M., Oida, S., Mimori, K., Iwasaki, K., Noguchi, K., Oda, S., and Ishikawa, I., *Twist negatively regulates osteoblastic differentiation in human periodontal ligament cells*. J Cell Biochem 2007; 100(2): 303-14.
369. Maestro, R., Dei Tos, A.P., Hamamori, Y., Krasnokutsky, S., Sartorelli, V., Kedes, L., Doglioni, C., Beach, D.H., and Hannon, G.J., *Twist is a potential oncogene that inhibits apoptosis*. Genes Dev 1999; 13(17): 2207-17.
370. Puisieux, A., Valsesia-Wittmann, S., and Ansieau, S., *A twist for survival and cancer progression*. Br J Cancer 2006; 94(1): 13-7.
371. Attardi, L.D., Lowe, S.W., Brugarolas, J., and Jacks, T., *Transcriptional activation by p53, but not induction of the p21 gene, is essential for oncogene-mediated apoptosis*. EMBO J 1996; 15(14): 3693-701.
372. Chen, X., Ko, L.J., Jayaraman, L., and Prives, C., *p53 levels, functional domains, and DNA damage determine the extent of the apoptotic response of tumor cells*. Genes Dev 1996; 10(19): 2438-51.
373. Deed, R.W., Hara, E., Atherton, G.T., Peters, G., and Norton, J.D., *Regulation of Id3 cell cycle function by Cdk-2-dependent phosphorylation*. Mol Cell Biol 1997; 17(12): 6815-21.
374. Desprez, P.Y., Hara, E., Bissell, M.J., and Campisi, J., *Suppression of mammary epithelial cell differentiation by the helix-loop-helix protein Id-1*. Mol Cell Biol 1995; 15(6): 3398-404.
375. Iavarone, A., Garg, P., Lasorella, A., Hsu, J., and Israel, M.A., *The helix-loop-helix protein Id-2 enhances cell proliferation and binds to the retinoblastoma protein*. Genes Dev 1994; 8(11): 1270-84.
376. Norton, J.D. and Atherton, G.T., *Coupling of cell growth control and apoptosis functions of Id proteins*. Mol Cell Biol 1998; 18(4): 2371-81.

377. Kikuchi, H., Suzuki, K., Sakai, N., and Yamada, S., *Odontoblasts induced from mesenchymal cells of murine dental papillae in three-dimensional cell culture*. Cell Tissue Res 2004; 317(2): 173-85.
378. Huang, G.T., Yamaza, T., Shea, L.D., Djouad, F., Kuhn, N.Z., Tuan, R.S., and Shi, S., *Stem/Progenitor cell-mediated de novo regeneration of dental pulp with newly deposited continuous layer of dentin in an in vivo model*. Tissue Eng Part A 2010; 16(2): 605-15.
379. Chung, U.I., Kawaguchi, H., Takato, T., and Nakamura, K., *Distinct osteogenic mechanisms of bones of distinct origins*. J Orthop Sci 2004; 9(4): 410-4.
380. Sharpe, P.T., *Neural crest and tooth morphogenesis*. Adv Dent Res 2001; 15: 4-7.
381. Hayashi, M., Nimura, K., Kashiwagi, K., Harada, T., Takaoka, K., Kato, H., Tamai, K., and Kaneda, Y., *Comparative roles of Twist-1 and Id1 in transcriptional regulation by BMP signaling*. J Cell Sci 2007; 120(Pt 8): 1350-7.
382. Centrella, M., Horowitz, M.C., Wozney, J.M., and McCarthy, T.L., *Transforming growth factor-beta gene family members and bone*. Endocr Rev 1994; 15(1): 27-39.
383. Hogan, B.L., *Bone morphogenetic proteins: multifunctional regulators of vertebrate development*. Genes Dev 1996; 10(13): 1580-94.
384. Sun, X.H., Copeland, N.G., Jenkins, N.A., and Baltimore, D., *Id proteins Id1 and Id2 selectively inhibit DNA binding by one class of helix-loop-helix proteins*. Mol Cell Biol 1991; 11(11): 5603-11.
385. Reinhold, M.I., Kapadia, R.M., Liao, Z., and Naski, M.C., *The Wnt-inducible transcription factor Twist1 inhibits chondrogenesis*. J Biol Chem 2006; 281(3): 1381-8.
386. Dong, Y.F., Soung do, Y., Chang, Y., Enomoto-Iwamoto, M., Paris, M., O'Keefe, R.J., Schwarz, E.M., and Drissi, H., *Transforming growth factor-beta and Wnt signals regulate chondrocyte differentiation through Twist1 in a stage-specific manner*. Mol Endocrinol 2007; 21(11): 2805-20.
387. Centrella, M., Casinghino, S., Kim, J., Pham, T., Rosen, V., Wozney, J., and McCarthy, T.L., *Independent changes in type I and type II receptors for transforming growth factor beta induced by bone morphogenetic protein 2 parallel expression of the osteoblast phenotype*. Mol Cell Biol 1995; 15(6): 3273-81.
388. Hu, J.S. and Olson, E.N., *Functional receptors for transforming growth factor-beta are retained by biochemically differentiated C2 myocytes in growth factor-deficient*

- medium containing EGTA but down-regulated during terminal differentiation.* J Biol Chem 1990; 265(14): 7914-9.
389. Zhou, S., Eid, K., and Glowacki, J., *Cooperation between TGF-beta and Wnt pathways during chondrocyte and adipocyte differentiation of human marrow stromal cells.* J Bone Miner Res 2004; 19(3): 463-70.
390. Zhou, S., Lechpammer, S., Greenberger, J.S., and Glowacki, J., *Hypoxia inhibition of adipocytogenesis in human bone marrow stromal cells requires transforming growth factor-beta/Smad3 signaling.* J Biol Chem 2005; 280(24): 22688-96.
391. Choy, L., Skillington, J., and Derynck, R., *Roles of autocrine TGF-beta receptor and Smad signaling in adipocyte differentiation.* J Cell Biol 2000; 149(3): 667-82.
392. Reya, T. and Clevers, H., *Wnt signalling in stem cells and cancer.* Nature 2005; 434(7035): 843-50.
393. Kato, M., Patel, M.S., Levasseur, R., Lobov, I., Chang, B.H., Glass, D.A., 2nd, Hartmann, C., Li, L., Hwang, T.H., Brayton, C.F., Lang, R.A., Karsenty, G., and Chan, L., *Cbfα1-independent decrease in osteoblast proliferation, osteopenia, and persistent embryonic eye vascularization in mice deficient in Lrp5, a Wnt coreceptor.* J Cell Biol 2002; 157(2): 303-14.
394. Kawai, M., Mushiake, S., Bessho, K., Murakami, M., Namba, N., Kokubu, C., Michigami, T., and Ozono, K., *Wnt/Lrp/beta-catenin signaling suppresses adipogenesis by inhibiting mutual activation of PPARgamma and C/EBPalpha.* Biochem Biophys Res Commun 2007; 363(2): 276-82.
395. Bennett, C.N., Ross, S.E., Longo, K.A., Bajnok, L., Hemati, N., Johnson, K.W., Harrison, S.D., and MacDougald, O.A., *Regulation of Wnt signaling during adipogenesis.* J Biol Chem 2002; 277(34): 30998-1004.
396. Ross, S.E., Hemati, N., Longo, K.A., Bennett, C.N., Lucas, P.C., Erickson, R.L., and MacDougald, O.A., *Inhibition of adipogenesis by Wnt signaling.* Science 2000; 289(5481): 950-3.
397. Liu, J. and Farmer, S.R., *Regulating the balance between peroxisome proliferator-activated receptor gamma and beta-catenin signaling during adipogenesis. A glycogen synthase kinase 3beta phosphorylation-defective mutant of beta-catenin inhibits expression of a subset of adipogenic genes.* J Biol Chem 2004; 279(43): 45020-7.

## Bibliography

398. Moldes, M., Zuo, Y., Morrison, R.F., Silva, D., Park, B.H., Liu, J., and Farmer, S.R., *Peroxisome-proliferator-activated receptor gamma suppresses Wnt/beta-catenin signalling during adipogenesis*. Biochem J 2003; 376(Pt 3): 607-13.
399. Bowers, R.R. and Lane, M.D., *Wnt signaling and adipocyte lineage commitment*. Cell Cycle 2008; 7(9): 1191-6.
400. Pan, D., Fujimoto, M., Lopes, A., and Wang, Y.X., *Twist-1 is a PPARdelta-inducible, negative-feedback regulator of PGC-1alpha in brown fat metabolism*. Cell 2009; 137(1): 73-86.
401. Mrozik, K.M., Zilm, P.S., Bagley, C., Hack, S., Hoffmann, P., Gronthos, S., and Bartold, P.M., *Proteomic characterization of mesenchymal stem cell-like populations derived from ovine periodontal ligament, dental pulp and bone marrow: analysis of differentially expressed proteins*. Stem Cells Dev 2010. Pre-Published online at DOI 10.1089/scd.2009.0446.