We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900
Open access books available

185,000
International authors and editors

200M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



27

RANK/RANKL Axis in Melanoma

Kanji Mori[1], Kosei Ando[1],
Frédéric Lézot[2] and Dominique Heymann[2]
[1]*Shiga University of Medical Science;*
[2]*Nantes University,*
[1]*Japan*
[2]*France*

1. Introduction

The TNF receptor superfamily member 11A known as receptor activator of nuclear factor κB (RANK/TNFRSF11A), its ligand RANKL (TNFSF11) and the decoy receptor for RANKL called osteoprotegerin (OPG/TNFRSF11B) have been shown to be key regulators of bone remodeling (Simonet et al., 1997; Lacey et al., 1998; Theoleyre et al., 2004). Indeed, RANKL mediates osteoclastogenesis and activates mature osteoclasts, whereas OPG negatively regulates RANKL binding to RANK, reduces the half-life of membranous RANKL and finally inhibits bone resorption by osteoclasts (Tat et al., 2006). Together with such part in bone, the RANK/RANKL axis is also involved in a variety of physiologic functions. Certainly, the RANK/RANKL axis controls the lymph-node organogenesis, the thymic medullary epithelial cells differentiation, the central thermoregulation, the formation of lactating mammary gland during pregnancy and the proliferation of epithelial cells of the epidermo-pilosebaceous unit (Dougall et al., 1999; Kong et al., 1999; Fata et al., 2000; Rossi et al., 2007; Hanada et al., 2009; Duheron et al., 2011).
In parallel to its physiologic functions, the RANK/RANKL axis has been also implicated in several pathologies, in particular in tumors with bone connections as bone primitive tumors and bone metastasis forming tumors. Thus, functional RANK expression has been reported in cells of different tumors, such as prostate and breast cancers, osteosarcoma and melanoma (Jones et al., 2006; Wittrant et al., 2006; Mori et al. 2007a, b, c). Moreover, RANKL was shown to trigger the migration of these RANK-expressing cells (Jones et al., 2006; Mori et al., 2007a). According to these observations, the RANK/RANKL axis might have a great impact on melanoma development. The aim of the present chapter is to discuss, based on the actual knowledge, the feasibility of targeting RANK/RANKL axis for the treatment of melanoma.

2. RANK/RANKL axis interest for melanoma treatment

2.1 RANK/RANKL, skin-appendages and skin

The RANK/RANKL axis has emerged as an important physiologic player in epithelial cell growth and differentiation. First evidences came from expression patterns of both RANK

and RANKL during the development of skin-appendages as hairs, teeth and mammary glands (Ohazama et al., 2004; Mikkola, 2008; Tanos & Brisken, 2008; Duheron et al., 2011). Regarding mammary glands, RANK and its ligand are both expressed in epithelial cells and control the development of a lactating mammary gland during pregnancy. In absence of RANK/RANKL signaling, the formation of lobulo-alveolar structures, necessary to a functional lactating mammary gland, is severely impaired leading to milk secretion defect.

Concerning hairs, RANK is expressed by the hair follicle germ, bulge stem cells and epidermal basal cells. Interestingly, these cell-types are implicated in the renewal of the epidermo-pilosebaceous unit. Its ligand (RANKL) is actively transcribed by the hair follicle at initiation of its growth phase, providing a mechanism for RANK-expressing stem cell engagement and hair-cycle entry. Mice deficient in RANKL are unable to initiate a new growth phase of the hair cycle and display arrested epidermal homeostasis. Furthermore, transgenic mice overexpressing RANK in the hair follicle or administration of recombinant RANKL both activate the hair cycle and epidermal growth. Finally, RANK signaling is dispensable for the formation of the stem cell compartment and the induction of hair follicle mesenchyme, but RANK-RANKL axis regulates hair renewal and epidermal homeostasis and provides a link between these two activities.

The RANK/RANKL axis also plays essential roles on immune system including participation in T-cell/dendritic cell communications (Leibbrandt & Penninger, 2010). Interestingly, RANKL over-expression in keratinocytes results in functional alterations of epidermal dendritic cells and systemic increases of regulatory CD4(+)CD25(+) T cells. Consequently, epidermal RANKL expression can modify dendritic cell functions to maintain the number of peripheral CD4(+)CD25(+) regulatory T cells. Finally, environmental stimuli at the skin level can rewire the local and systemic immune system by means of RANKL.

2.2 RANK/RANKL and bone-associated cancers

Since the late nineteenth century, it has been thought that the microenvironment of the local host tissue actively participates in the tendency of some cancers to metastasize to specific organs (Paget, 1889). However, the specific factors involved are still unknown.

Bones are continuously remodeled throughout life by two complementary processes: bone matrix formation (apposition) regulated by osteoblasts and bone resorption managed by osteoclasts. The precise inter-relation between osteoblasts and osteoclasts leading to osteoclastogenesis is only partly deciphered. The discovery of certain key factors involved in the control of osteoclastogenesis has moved bone research into a new era. Current findings have revealed that the RANKL/RANK/OPG molecular triad constitutes a key regulator for both normal and pathological bone metabolism (Brown et al., 2001; Goltzman, 2001; Chen, et al. 2006). The prevention of different tumors metastases inheritance in bone by RANKL inhibitors [*i.e.*, OPG or soluble RANK (sRANK) or RANK blocking antibodies (RANK-Fc)] in established animal models of bone metastases, highlights the critical role of this triad in cancer-induced bone manifestations (Zhang et al., 2001, 2003; Corey et al., 2005; Whang et al., 2005; Mountzios et al., 2007; Canon et al, 2008). Interestingly, such anti-tumor effects appear to be restricted to bone models. Indeed, such effects have not been observed in any other models, including classical subcutaneous models (Zhang et al., 2001, 2003). Thus, it

was first believed that anti-tumor effects induced by RANKL/RANK interaction blockage were the result of an indirect effect *via* osteoclasts.

In turn, functional RANK expression was recently reported in bone-associated tumors, more precisely in cells of breast cancer, prostate cancer, osteosarcoma and malignant melanoma (Jones et al., 2006; Wittrant et al., 2006; Mori et al., 2007a, b, c; Armstrong et al., 2008). According to the fact that RANK-expressing tumor cells migration was induced by RANKL stimulation (Armstrong et al., 2008; Jones et al., 2006; Mori et al., 2007a), the direct effect of RANKL on RANK-expressing tumor cells was in fine disclosed. Consequently, RANKL works, in bone, as one of the "soil" factors of Paget's theory (Fig. 1).

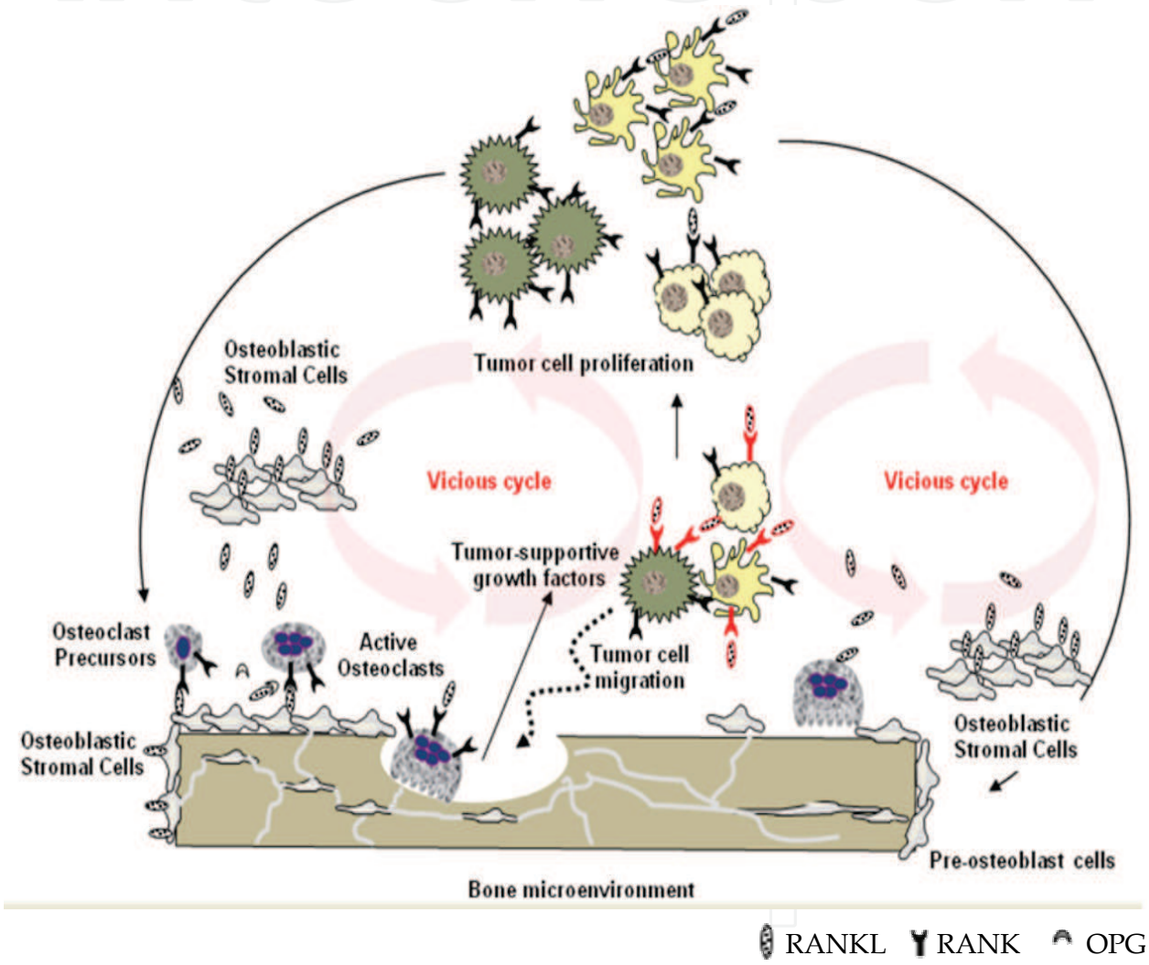


Fig. 1. Schematic representation of the putative interactions between RANK-expressing tumor cells (*i.e.,* prostate cancer, breast cancer and malignant melanoma) and bone cells (osteoblasts and osteoclasts) in the tumoral bone microenvironment

In fact, RANK-expressing tumor cells would preferentially targeted bone microenvironment where RANKL concentration is elevated. In the bone tumoral environment, RANKL produced by osteoblasts and bone stromal cells has two potential targets: on the one hand the osteoclast precursor and the osteoclast, and on the other hand the RANK-expressing

tumor cell. So RANKL acts as a "soil" factor that facilitates cancer metastasis settlement in bone by activating both kinds of RANK-expressing cells.

2.3 Melanomas: skin tumors with bone metastasis

Melanoma belongs to the large family of skin tumors (see WHO classification of skin tumors: In Pathology and Genetics of Skin Tumors edited by P.E. LeBoit, G. Burg, D. Weedon and A. Sarasin, IARC Press, Lyon, 2006). From a clinical and public health point of view, malignant melanomas are the most important group of skin tumors. Although less common than basal and squamous cell tumors of the skin, they are much more often fatal, due to their intrinsic propensity to metastasis. The major environmental risk factor for melanoma is recurrent expositions to high-doses of UV radiations. Endogenous factors are often combined as genetic susceptibility. Bone metastasis is a poor prognostic for patient and corresponds to the ultimate stage of the pathology. The precise implication of RANK/RANKL axis in the bone metastatic process has been controversial but nowadays it seems clear that this signalization plays successive parts in this complex process. Indeed, RANK/RANKL axis is implicated in tumor cell migration (as previously described) and later in tumor cell settlement in the bone microenvironment and induction of osteolysis (Mundy, 2002; Jones et al., 2006). Consequently, targeting RANK/RANKL signalization might be a promising strategy to prevent melanoma bone metastasis and subsequent damages.

2.4 Targeting RANK/RANKL axis for melanoma treatment: benefit/risk

According to the disastrous consequences of melanoma metastasis in term of patient survival, any treatments that enable confinement of tumor cells to their initial site has to be considered as therapeutically beneficial. RANK/RANKL inhibitors, due to the implication of RANK/RANKL axis in metastatic process, are so potentially highly relevant therapeutic agents for melanoma. They may reduce the incidence of metastasis and synergized with anti-tumoral drugs. Indeed, several studies has been reported such beneficial effect of OPG (Lamoureux et al., 2007), OPG peptide (Heymann et al., 2005), RANK-Fc (Lamoureux et al., 2008) and Denosumab (fully human anti-RANKL antibody) (Abrahamsen et al., 2005) as RANK/RANKL inhibitors for the treatment of bone-associated cancers.

However, as presented above, the RANK/RANKL signalization is implicated in various physiological processes during development and takes part to the immune response. So targeting this pathway in children may have developmental consequences that need to be evaluated. Moreover, whatever the age of the patient, the potential impact of such inhibitor on the immune response as to be taken into account and may in fine limited their use.

3. Conclusion

The use of drugs targeting the RANK/RANKL axis in melanoma appears to be a promising strategy to reduce the mortality of this skin cancer. Such drugs should reduce the metastatic process and enforce the action of classical anti-tumoral treatment. However, further studies will be necessary to evaluate the impact of these drugs on RANK/RANKL signaling physiological functions, more specifically during growth, and to deal with these drugs potential wrong impact on immune system.

4. Acknowledgment

This work was supported by INSERM and by the French Ministry of Research.

5. References

Abrahamsen, B. & Teng, A.Y. (2005). Technology evaluation: denosumab, Amgen. *Curr Opin Mol Ther* Vol.7, No.6, (December), pp. 604-610, ISSN 1464-8431

Armstrong, A.P.; Miller, R.E.; Jones, J.C.; Zhang, J.; Keller, E.T. & Dougall, W.C. (2008). RANKL acts directly on RANK-expressing prostate tumor cells and mediates migration and expression of tumor metastasis genes. *Prostate* Vol.68, No.1, (January), pp. 92-104, ISSN 0270-4137

Brown, J.M.; Corey, E.; Lee, Z.D.; True, L.D.; Yun, T.J.; Tondravi, M. & Vessella, R.L. (2001). Osteoprotegerin and rank ligand expression in prostate cancer. *Urology* Vol.57, No.4, (April), pp. 611-616, ISSN 0090-4295

Canon, J.R.; Roudier, M. & Bryant, R. (2008). Inhibition of RANKL blocks skeletal tumor progression and improves survival in a mouse model of breast cancer bone metastasis. *Clin Exp Metastasis* Vol.25, No.2, pp. 119-129.

Chen, G.; Sircar, K.; Aprikian, A.; Potti, A.; Goltzman, D. & Rabbani, S.A. (2006). Expression of RANKL/RANK/OPG in primary and metastatic human prostate cancer as markers of disease stage and functional regulation. *Cancer* Vol.107, No.2, (July), pp. 289-298, ISSN 0008-543X

Corey, E.; Brown, L.G.; Kiefer, J.A.; Quinn, J.E.; Pitts, T.E.; Blair, J.M. & Vessella, R.L. (2005). Osteoprotegerin in prostate cancer bone metastasis. *Cancer Res* Vol.65, No.5, (March), pp. 1710-1718, ISSN 0008-5472

Dougall, W.C.; Glaccum, M.; Charrier, K.; Rohrbach, K.; Brasel, K.; De Smedt, T.; Daro, E.; Smith, J.; Tometsko, M.E.; Maliszewski, C.R.; Armstrong, A.; Shen, V.; Bain, S.; Cosman, D.; Anderson, D.; Morrissey, P.J.; Peschon, J.J. & Schuh, J. (1999). RANK is essential for osteoclast and lymph node development. *Genes Dev* Vol.13, No.18, (September), pp2412–2424, ISSN 0890-9369

Duheron, V.; Hess, E.; Duval, M.; Decossas, M.; Castaneda, B.; Klöpper, J.E.; Amoasii, L.; Barbaroux, J.B.; Williams, I.R.; Yagita, H.; Penninger, J.; Choi, Y.; Lézot, F.; Groves, R.; Paus, R. & Mueller, C.G. (2011). Receptor activator of NF-{kappa}B (RANK) stimulates the proliferation of epithelial cells of the epidermo-pilosebaceous unit. *Proc Natl Acad Sci U S A*. Vol.108, No.13, (March), pp. 5342-5347, ISSN 0027-8424

Fata, J.E.; Kong, Y.Y.; Li, J.; Sasaki, T.; Irie-Sasaki, J.; Moorehead, R.A.; Elliott, R.; Scully, S.; Voura, E.B.; Lacey, D.L.; Boyle, W.J.; Khokha, R. & Penninger, J.M. (2000). The osteoclast differentiation factor osteoprotegerin-ligand is essential for mammary gland development. *Cell* Vol.103, No.1, (September), pp. 41–50, ISSN 0092-8674

Goltzman, D. (2001). Osteolysis and cancer. *J Clin Invest* Vol.107, No.10, (May), pp. 1219-1220, ISSN 0021-9738

Hanada, R.; Leibbrandt, A.; Hanada, T.; Kitaoka, S.; Furuyashiki, T.; Fujihara, H.; Trichereau, J.; Paolino, M.; Qadri, F.; Plehm, R.; Klaere, S.; Komnenovic, V.; Mimata, H.; Yoshimatsu, H.; Takahashi, N.; von Haeseler, A.; Bader, M.; Kilic, S.S.; Ueta, Y.; Pifl, C.; Narumiya, S. & Penninger, J.M. (2009). Central control of fever and female

body temperature by RANKL/RANK. *Nature* Vol.462, No.7272, (November), pp. 505–509, ISSN 0028-0836

Heymann, D.; Fortun, Y.; Rédini, F. & Padrines, M. (2005). Osteolytic bone diseases: physiological analogues of bone resorption effectors as alternative therapeutic tools. *Drug Discov Today* Vol.10, No.4, (February), pp. 242-247, ISSN 1359-6446

Jones, D.H.; Nakashima, T.; Sanchez, O.H.; Kozieradzki, I.; Komarova, S.V.; Sarosi, I.; Morony, S.; Rubin, E.; Sarao, R.; Hojilla, C.V.; Komnenovic, V.; Kong, Y.Y.; Schreiber, M.; Dixon, S.J.; Sims, S.M.; Khokha, R.; Wada, T. & Penninger, J.M. Regulation of cancer cell migration and bone metastasis by RANKL. (2006) *Nature* Vo.440, No.7084, (March), pp. 692-696, ISSN 0028-0836

Kong, Y.Y.; Yoshida, H.; Sarosi, I.; Tan, H.L.; Timms, E.; Capparelli, C.; Morony, S.; Oliveira-dos-Santos, A.J.; Van, G.; Itie, A.; Khoo, W.; Wakeham, A.; Dunstan, C.R.; Lacey, D.L.; Mak, T.W.; Boyle, W.J. & Penninger, J.M. (1999). OPGL is a key regulator of osteoclastogenesis, lymphocyte development and lymph-node organogenesis. *Nature* Vol.397, No.6717, (January), pp. 315–323, ISSN 0028-0836

Lacey, D.L.; Timms, E.; Tan, H.L.; Kelley, M.J.; Dunstan, C.R.; Burgess, T.; Elliott, R.; Colombero, A.;, Elliott, G.; Scully, S.; Hsu, H.; Sullivan, J.; Hawkins, N.; Davy, E.; Capparelli, C.; Eli, A.; Qian, Y.X.; Kaufman, S.; Sarosi, I.; Shalhoub, V.; Senaldi, G.; Guo, J.; Delaney, J. & Boyle, W.J. (1998). Osteoprotegerin ligand is a cytokine that regulates osteoclast differentiation and activation. *Cell* Vol.93, No.2, (April), pp. 165-176, ISSN 0092-8674

Lamoureux, F.; Richard, P.; Wittrant, Y.; Battaglia, S.; Pilet, P.; Trichet, V.; Blanchard, F.; Gouin, F.; Pitard, B.; Heymann, D. & Redini, F. (2007). Therapeutic relevance of osteoprotegerin gene therapy in osteosarcoma: blockade of the vicious cycle between tumor cell proliferation and bone resorption. *Cancer Res* Vol.67, No.15, (August), pp. 7308-7318, ISSN 0008-5472

Lamoureux, F.; Picarda, G.; Rousseau, J.; Gourden, C.; Battaglia, S.; Charrier, C.; Pitard, B.; Heymann, D. & Rédini, F. (2008). Therapeutic efficacy of soluble receptor activator of nuclear factor-kappa B-Fc delivered by nonviral gene transfer in a mouse model of osteolytic osteosarcoma. *Mol Cancer Ther* Vol.7, No.10, (October), pp. 3389-3398, ISSN 1535-7163

Leibbrandt, A. & Penninger, J.M. (2010). Novel Functions of RANK(L) Signaling in the Immune System. *Adv Exp Med Biol* Vol.658, pp. 77-94, ISSN 0065-2598

Mikkola, M.L. (2008). TNF superfamily in skin appendage development. *Cytokine Growth Factor Rev* Vol.19, No.3-4, (June-August), pp. 219-230, ISSN 1359-6101

Mori, K.; Le Goff, B.; Charrier, C.; Battaglia, S.; Heymann, D. & Rédini, F. (2007a). DU145 human prostate cancer cells express functional receptor activator of NFkappaB: new insights in the prostate cancer bone metastasis process. *Bone* Vol.40, No.4, (April), pp. 981-90, ISSN 8756-3282

Mori, K.; Le Goff, B.; Berreur, M.; Riet, A.; Moreau, A.; Blanchard, F.; Chevalier, C.; Guisle-Marsollier, I.; Léger, J.; Guicheux, J.; Masson, M.; Gouin, F.; Rédini, F. & Heymann, D. (2007b). Human osteosarcoma cells express functional receptor activator of nuclear factor-kappa B. *J Pathol* Vol.211, No.5, (April), pp. 555-562, ISSN 0022-3417

Mori, K.; Berreur, M.; Blanchard, F.; Chevalier, C.; Guisle-Marsollier, I.; Masson, M.; Rédini, F. & Heymann, D. (2007c) Receptor activator of nuclear factor-kappaB ligand (RANKL) directly modulates the gene expression profile of RANK-positive Saos-2 human osteosarcoma cells. *Oncol Rep* Vol.18, No.6, (December), pp.1365-1371, ISSN1021-335X

Mountzios, G.; Dimopoulos, M.A.; Bamias, A.; Papadopoulos, G.; Kastritis, E.; Syrigos, K.; Pavlakis, G. & Terpos, E. (2007). Abnormal bone remodeling process is due to an imbalance in the receptor activator of nuclear factor-kappaB ligand (RANKL)/osteoprotegerin (OPG) axis in patients with solid tumors metastatic to the skeleton. *Acta Oncol* Vol.46, No.2, pp. 221-229, ISSN 0284-186X

Ohazama, A.; Courtney, J.M. & Sharpe, P.T. (2004). Opg, Rank, and Rankl in tooth development: co-ordination of odontogenesis and osteogenesis. *J Dent Res* Vol.83, No.3, (March), pp. 241-244, ISSN 0022-0345

Paget, S. (1889). The distrubution of secondary growths in cancer of the breast. Lancet Vol.1, pp. 571-572, ISSN 0140-6736

Rossi, S.W.; Kim, M.Y.; Leibbrandt, A.; Parnell, S.M.; Jenkinson, W.E.; Glanville, S.H.; McConnell, F.M.; Scott, H.S.; Penninger, J.M.; Jenkinson, E.J.; Lane, P.J. & Anderson, G. (2007). RANK signals from CD4(+)3(-) inducer cells regulate development of Aire-expressing epithelial cells in the thymic medulla. *J Exp Med* Vol.204, No.6, (June), pp. 1267–1272, ISSN 0022-1007

Simonet, W.S.; Lacey, D.L.; Dunstan, C.R.; Kelley, M.; Chang, M.S.; Lüthy, R.; Nguyen, H.Q.; Wooden, S.; Bennett, L.; Boone, T.; Shimamoto, G.; DeRose, M.; Elliott, R.; Colombero, A.; Tan, H.L.; Trail, G.; Sullivan, J.; Davy, E.; Bucay, N.; Renshaw-Gegg, L.; Hughes, T.M.; Hill, D.; Pattison, W.; Campbell, P.; Sander, S.; Van, G.; Tarpley, J.; Derby, P.; Lee, R. & Boyle, W.J. (1997). Osteoprotegerin: a novel secreted protein involved in the regulation of bone density. *Cell* Vol.89, No.2, (April) pp. 309-319, ISSN 0092-8674

Tanos, T. & Brisken, C. (2008). What signals operate in the mammary niche? *Breast Dis* Vol.29, pp.69-82,

Tat, S.K.; Padrines, M.; Theoleyre, S.; Couillaud-Battaglia, S.; Heymann, D.; Redini, F. & Fortun, Y. (2006). OPG/membranous -RANKL complex is internalized via the clathrin pathway before a lysosomal and a proteasomal degradation. *Bone* Vol.39, No.4, (October) pp. 706-715, ISSN 8756-3282

Theoleyre, S.; Wittrant, Y.; Tat, S.K.; Fortun, Y.; Redini, F. & Heymann, D. (2004). The molecular triad OPG/RANK/RANKL: involvement in the orchestration of pathophysiological bone remodeling. *Cytokine Growth Factor Rev* Vol.15, No.6, (December), pp. 457-475, ISSN 1359-6101

Whang, P.G.; Schwarz, E.M.; Gamradt, S.C.; Dougall, W.C. & Lieberman, J.R. (2005) The effects of RANK blockade and osteoclast depletion in a model of pure osteoblastic prostate cancer metastasis in bone. *J Orthop Res* Vol.23, No.6, (November), pp. 1475-1483, ISSN 0736-0266

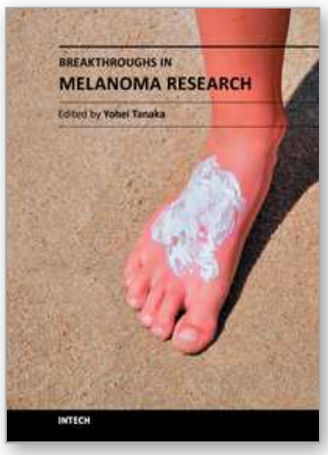
Wittrant, Y.; Lamoureux, F.; Mori, K.; Riet, A.; Kamijo, A.; Heymann, D. & Redini, F. (2006) RANKL directly induces bone morphogenetic protein-2 expression in RANK-expressing POS-1 osteosarcoma cells. *Int J Oncol* Vol.28, No.1, (January), pp. 261-269, ISSN 1019-6439

Zhang, J.; Dai, J.; Qi, Y.; Lin, D.L.; Smith, P.; Strayhorn, C.; Mizokami, A.; Fu, Z.; Westman, J. & Keller, E.T. (2001). Osteoprotegerin inhibits prostate cancer-induced osteoclastogenesis and prevents prostate tumor growth in the bone. *J Clin Invest* Vol.107, No.10, (May), pp. 1235-1244, ISSN 0021-9738

Zhang, J.; Dai, J.; Yao, Z.; Lu, Y.; Dougall, W. & Keller, E.T. (2003) Soluble receptor activator of nuclear factor kappaB Fc diminishes prostate cancer progression in bone. *Cancer Res* Vol.63, No.22, (November), pp. 7883-7890. ISSN 0008-5472

IntechOpen

IntechOpen



Breakthroughs in Melanoma Research
Edited by Dr Yohei Tanaka

ISBN 978-953-307-291-3
Hard cover, 628 pages
Publisher InTech
Published online 30, June, 2011
Published in print edition June, 2011

Melanoma is considered to be one of the most aggressive forms of skin neoplasms. Despite aggressive researches towards finding treatments, no effective therapy exists to inhibit the metastatic spread of malignant melanoma. The 5-year survival rate of metastatic melanoma is still significantly low, and there has been an earnest need to develop more effective therapies with greater anti-melanoma activity. Through the accomplishment of over 100 distinguished and respected researchers from 19 different countries, this book covers a wide range of aspects from various standpoints and issues related to melanoma. These include the biology of melanoma, pigmentations, pathways, receptors and diagnosis, and the latest treatments and therapies to make potential new therapies. Not only will this be beneficial for readers, but it will also contribute to scientists making further breakthroughs in melanoma research.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Kanji Mori, Kosei Ando, Frédéric Lézot and Dominique Heymann (2011). RANK/RANKL Axis in Melanoma, Breakthroughs in Melanoma Research, Dr Yohei Tanaka (Ed.), ISBN: 978-953-307-291-3, InTech, Available from: http://www.intechopen.com/books/breakthroughs-in-melanoma-research/rank-rankl-axis-in-melanoma

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2011 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the Creative Commons Attribution 3.0 License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen