CELLULAR BASIS OF BONE REMODELING

EMMA OBRADORS LLOBET
Grau en Biologia

INTRODUCTION

The bone is subjected to a continuous process of renewal which is known as bone remodeling.

This process is accomplished by destroying osteoclasts by small microscopic tissue units, called bone remodeling units (BRU), which are then replaced by new tissue formed by osteoblasts.

Components:

- Extracellular matrix: organic part and inorganic part.

- Cells: osteoclasts, osteoblasts, osteocytes, immune cells, megakaryocytes and osteomacs.

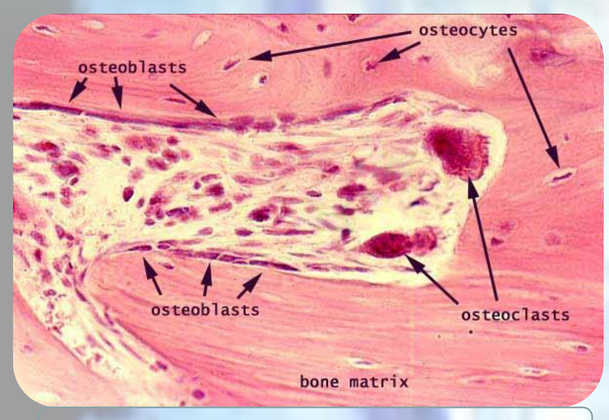

Fig. 1- Different bone cells

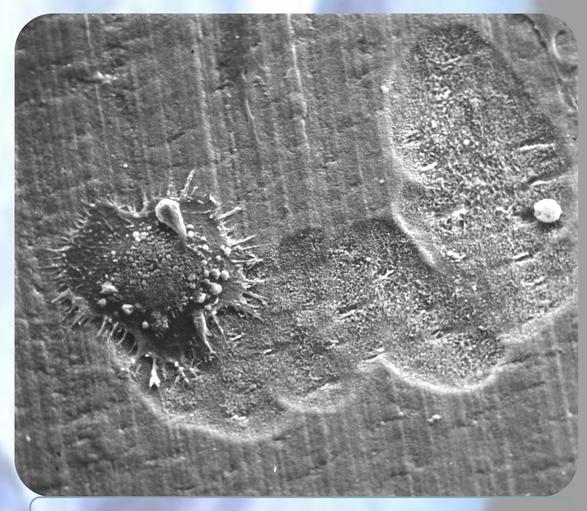

Fig. 2- Osteoclasts during resorption

THE PROCESS

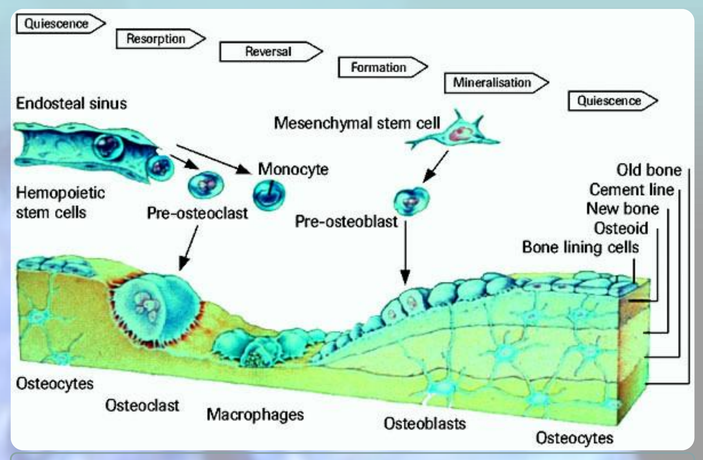

Fig. 3- Phases of bone remodeling

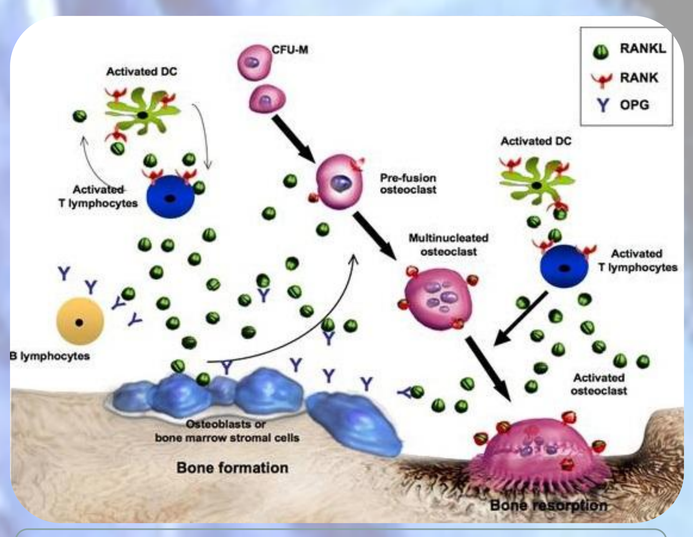

Fig. 4- Transcription factors in bone formation and bone resorption

- **Activation phase**:
This phase requires that detects a signal initiator of remodeling.
It generates apoptosis of osteocitos and increases osteoclastogenesis.
This induces a wave of transcriptional responses that produce or modulate the secretion of molecules that recruit precursors of osteoclasts, induce the activation and differentiation of osteolasts and bone resorption is establish.

- **Resorption phase**:
Osteoblasts respond to signals generated by osteocitos or endocrine activation signals and recruited osteoclasts precursors to the site of remodeling.
Osteoblasts generates MCP-1 and attracts osteoclasts.
Stimulation of RANKL induce osteoclastogenesis.
OPG reduces and CSF-1 and RANKL increases to promote osteoclasts formation.
Sealing zone produce Howship's lacunae.

- **Reversion phase**:
Reversal cells and osteomacs remove unmineralized matrix of Howship's lagoon.
Mesenchymal cells deposit new matrix collagenized.

- **Formation phase**:
Osteoclasts produce coupling factors: EphB4 recruit osteoblasts and the complex c-fos/NFATc1 activate bone formation and inhibit resorption.
Osteoblasts create bone in the lagoon.

- **Termination phase**:
When bone produce is finished starts mineralization.
Finally osteoblasts undergo apoptosis or differentiate into osteocytes.
The rest of the bone surface environment is restored and maintained until the next remodeling.

ALTERATIONS IN BONE REMODELING

Bone is in constant replacement or remodeling in response to mechanical stimuli and the weight or load, the calcium needs and other minerals in the body.

These processes are coupled, so if it increases or decreases the normal reabsorption follows an increase or decrease in bone formation, without a change in the net amount of bone mass.

When this is not so is when diseases appear such as osteoporosis, when there is a decrease in bone strength, due to an alteration in remodeling.

Secondary osteoporosis is the most common and associated with the elderly, hyperparathyroidism, menopause and reduced physical activity.

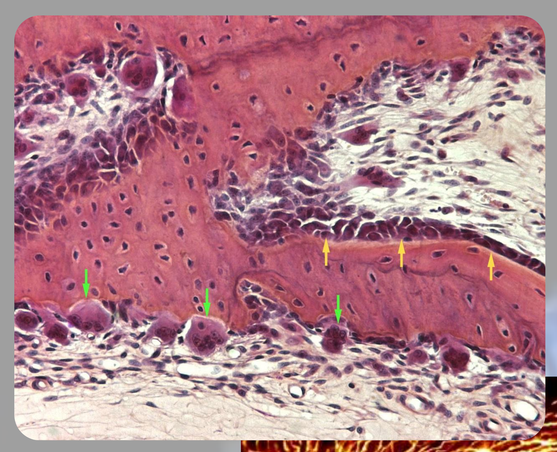

Fig. 5- Bone turnover

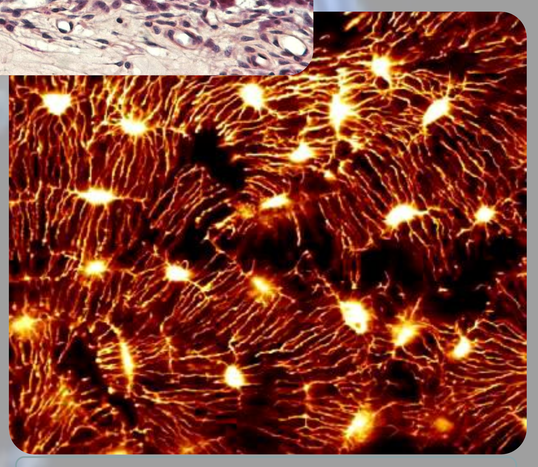

Fig. 6- Stained osteocytes

CONCLUSIONS

Bone remodeling implies tight coupling and regulation of osteoclasts and osteoblasts, and is modulated by a wide variety of hormones.

We can conclude that bone remodeling process is incomplete and deficient in understanding the complete mechanisms to couple bone resorption and formation, that implies an unsuccessful treatment of some pathological bone diseases that result in bone loss.

.

UAB
Universitat Autònoma de Barcelona