

Activity 3E: ABNORMAL BONE REMODELING – THE OSTEO BLASTER/CLASTER WHEEL, CONTINUED TEACHER PAGE

ABNORMAL BONE REMODELING

Key Concept—Coupling

Osteoblasts and osteoclasts work together. Their activities in building and resorbing bone are said to be “coupled.” When appropriately coupled, bone remodeling is in balance and there is no net gain or loss of bone mass. Osteoblast and osteoclast activity may become uncoupled in certain diseases.

While healthy bone remodeling occurs at many simultaneous sites throughout the body, there are instances wherein “disordered coupling” or abnormal remodeling occurs. This imbalance in the osteoclast and osteoblast activity affects bone health by leaving bone more fragile, more prone to breaks even during the most common of events — such as slipping from a curb, turning an ankle, even a hearty sneeze!

In one instance, the “disordered coupling” is due to a decrease in the osteoblast activity, even though osteoclasts are behaving normally. This reduced “blast” activity replaces only some of the bone tissue removed by the “clast” activity. The osteoclasts resorb the bone tissue as in normal bone remodeling, but the osteoblasts cannot keep up with the tissue loss. The osteoblast activity level is decreased. Thus resorption pits are not filled completely and bone becomes weakened. This phenomenon occurs during the aging process, but can also occur earlier in life due to excessive consumption of alcohol.

In the second instance, the “disordered coupling” is caused by excessive osteoclast activity, while the osteoblast activity remains “normal.” In other words, the osteoclasts dig out resorption pits that are much deeper than those that occur during normal bone remodeling. The osteoblast, while working to full capacity, cannot fill these deeper pits. Once again, the bone becomes weakened. This phenomenon normally occurs in women during and following menopause. It also occurs in those who suffer with *anorexia nervosa* or in those whose parathyroid glands do not function properly (hyperparathyroidism). One other condition in which the “clast” activity is excessive is in the disease known as osteoporosis. Osteoporosis is explored in more detail in Lesson Five of this unit.

Examine the chart provided which depicts the slight, but important changes that occur during the five phases in the bone remodeling process: ACTIVATION, RESORPTION, REVERSAL, FORMATION, and QUIESCENCE. Compare this with the chart provided in Activity 3D.

Have each student take out their own copy of *The “Osteo Blaster/Cluster” Wheel* that they constructed in Activity 3D. In this activity, the students will connect two additional parts to their *Blaster/Cluster Wheels* that will illustrate abnormal bone remodeling or “disordered coupling.” Put the wheel cover over “wheel A” to look at the phase events in the normal aging process and those in the case of alcohol abuse. By putting the cover on “wheel B,” the students will examine the phase events that occur during osteoporosis, menopause, anorexia, and parathyroid hormone imbalance.

The information on the Abnormal Bone Remodeling Chart in this section describes some of the events that occur during abnormal bone remodeling or “disordered coupling.” Use this chart to describe what students will be seeing in wheels “A” and “B.” Have the students place their “window” on number one, then follow along as you describe the events for each wheel. After the information for all eleven sections are discussed, hand out *The Triple Venn Diagram Worksheet*. Have students compare and contrast the phase events in each type of disordered coupling with the phase events that occur in normal, ordered coupling.

ABNORMAL BONE REMODELING CHART

Abnormal Bone Remodeling- “Disordered Coupling”
Imbalance in Osteoblasts and Osteoclasts, “blast/clast,” activity

– PHASE –	– PHASE EVENTS –	
	Usual Aging Process or Alcohol Abuse “Clast” activity normal; “Blast activity decreased	Osteoporosis, Menopause, <i>Anorexia Nervosa</i> , Hyperparathyroidism “Clast” activity excessive; “Blast activity normal
ACTIVATION	1. Pre-osteoclasts are attracted to <i>fewer</i> remodeling sites.	1. Pre-osteoclasts are attracted to <i>increased</i> remodeling sites.
	2. Pre-osteoclasts fuse to form multinucleated osteoclasts.	2. Pre-osteoclasts fuse to form multinucleated osteoclasts.
RESORPTION	3. Osteoclasts dig out a cavity, called a resorption pit, in spongy bone or burrow a tunnel in compact bone.	3. Osteoclasts dig out a cavity, called a resorption pit, in spongy bone or burrow a tunnel, but <i>too much activity</i> ...
	4. Calcium can be released into the blood for use in various body functions.	4. ...makes <i>pit or burrow deeper</i> which erodes tissue; calcium can be released into the blood for use in various body functions.
	5. Osteoclasts disappear.	5. Osteoclasts disappear.
REVERSAL	6. Mesenchymal stem cells, <i>pre-cursors</i> to osteoblasts, appear along the burrow or pit where they...	6. Mesenchymal stem cells, <i>pre-cursors</i> to osteoblasts, appear along the burrow or pit where they...
	7. ... <i>proliferate</i> (increase in numbers) and <i>differentiate</i> (change) into pre-osteoblasts, then	7. ... <i>proliferate</i> (increase in numbers) and <i>differentiate</i> (change) into pre-osteoblasts, then
FORMATION	8. <i>mature</i> into osteoblasts at the surface of the burrow or pit, but ...	8. <i>mature</i> into osteoblasts at the surface of the burrow or pit, but ...
	9. ... with decreased osteoblast activity release <i>some osteoid</i> to form a new soft nonmineralized matrix, but cannot restore the burrow or pit to its original status.	9. ... while normal osteoblast activity releases adequate <i>osteoid</i> to form a new soft nonmineralized matrix, it is not enough to restore the burrow or pit to its original status.
	10. The new matrix is mineralized with calcium and phosphorous.	10. The new matrix is mineralized with calcium and phosphorous.
QUIESCENCE	11. Site, with resting lining cells, remains <i>dormant</i> , but <i>not completely filled</i> , awaiting the next cycle.	11. Site, with resting lining cells, remains <i>dormant</i> , but <i>not completely filled</i> , awaiting the next cycle.