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Bone Marrow, Bone Growth, and Remodeling

Exam — Musculoskeletal System

Pre-med/IB-style MCQs on red vs yellow marrow, hematopoiesis, bone growth (endochondral vs intramembranous), growth plates, and the roles/regulation of osteoblasts, osteocytes, and osteoclasts.

40 items — Printable Exam

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1 Which statement BEST describes the main functional difference between red and yellow bone marrow in a healthy adult?

- A** Red marrow stores fat for long-term energy; yellow marrow produces most blood cells.
- B** Red marrow is the main site of blood cell production; yellow marrow is mainly fat storage.
- C** Red marrow forms the bone matrix; yellow marrow forms cartilage.
- D** Red marrow produces only platelets; yellow marrow produces only red blood cells.
- E** Red marrow is found only in children; yellow marrow is found only in adults.



2 In a healthy adult, most active red bone marrow is found primarily in the:

- A** Diaphysis (shaft) of the femur and tibia
- B** Distal phalanges of the fingers
- C** Axial skeleton (e.g., pelvis, vertebrae, sternum, ribs) and proximal ends of some long bones
- D** Outer epidermis and dermis
- E** Articular cartilage of joints



3 Which pairing is correct for where key lymphocytes mature?

- A** B cells mature in the thymus; T cells mature in bone marrow
- B** B cells mature in bone marrow; T cells mature in the thymus
- C** Both B and T cells mature mainly in the spleen
- D** Both B and T cells mature mainly in the liver in adults
- E** Neither B nor T cells mature in any organ; they mature only in blood





4 After severe blood loss, the body needs increased blood cell production. Which adaptive change can occur in bone marrow?



- A** Red marrow is permanently replaced by yellow marrow to save energy.
- B** Yellow marrow is replaced by cartilage to stabilize the bone.
- C** Osteoclasts stop functioning so that marrow can fill with blood.
- D** Some yellow marrow can convert back toward red marrow to increase hematopoiesis.
- E** The bone marrow switches to making hormones instead of blood cells.

5 A hallmark feature of hematopoietic stem cells (HSCs) is that they can:



- A** Self-renew and give rise to multiple blood cell lineages
- B** Differentiate only into red blood cells, never immune cells
- C** Turn directly into osteoclasts without any intermediate steps
- D** Divide only once and then permanently stop
- E** Produce ATP for the body as their main role

6 Platelets are produced most directly by:



- A** Mature red blood cells splitting in half
- B** Neutrophils releasing membrane fragments
- C** Osteoblasts secreting clotting vesicles
- D** Plasma proteins assembling into discs
- E** Fragmentation of megakaryocytes in the bone marrow





7 At high altitude, oxygen levels are lower. Over time, many people produce more red blood cells. Which hormone most directly drives this increase in RBC production?



- A** Insulin
- B** Erythropoietin (EPO)
- C** ADH
- D** Calcitonin
- E** Aldosterone

8 Which pairing correctly matches the typical developmental origin of osteoblasts and osteoclasts?



- A** Osteoblasts: hematopoietic stem cells; Osteoclasts: mesenchymal stem cells
- B** Osteoblasts: mesenchymal stem cells; Osteoclasts: hematopoietic/monocyte lineage
- C** Both osteoblasts and osteoclasts: mature red blood cells
- D** Both osteoblasts and osteoclasts: neurons
- E** Osteoblasts: viruses; Osteoclasts: bacteria

9 Which bone cell is most directly responsible for resorbing (breaking down) bone tissue?



- A** Osteoblast
- B** Osteocyte
- C** Chondrocyte
- D** Osteoclast
- E** Erythrocyte





10 A cell in bone sits in a lacuna and extends long processes through canaliculi to communicate with nearby cells and sense mechanical stress. This cell is most likely a(n):



- A** Osteocyte
- B** Osteoclast
- C** Osteoblast
- D** Megakaryocyte
- E** Hepatocyte

11 Which event is most directly associated with osteoblast activity?



- A** Secretion of osteoid (collagen-rich matrix) that later mineralizes
- B** Digestion of bone using acid at a ruffled border
- C** Formation of platelets from cytoplasmic fragments
- D** Fusion of multiple monocytes to form a multinucleated resorbing cell
- E** Production of antibodies as the main function

12 After the growth plates close, bones can still increase in thickness. Which process is primarily responsible for this increase in diameter?



- A** Endochondral ossification at the epiphyseal plate
- B** Appositional growth: osteoblasts add new bone on the periosteal surface
- C** Chondrocytes dividing inside articular cartilage
- D** Binary fission of osteocytes





- E Conversion of bone into cartilage to make it flexible

13 Endochondral ossification is best described as:



- A Bone forming directly from mesenchymal tissue without a cartilage stage
- B Bone forming by replacing a cartilage model with bone tissue
- C Cartilage forming by replacing bone tissue
- D Bone forming only after birth in all bones
- E Bone forming only in the skull

14 Intramembranous ossification is most associated with forming:



- A Most long bones (femur, tibia)
- B Many flat bones of the skull (and parts of the clavicle)
- C Articular cartilage at joints
- D Intervertebral discs
- E Bone only after fractures, never during development

15 Longitudinal growth of a long bone in a child occurs primarily because:



- A Osteocytes divide rapidly in the diaphysis and push the bone longer
- B Chondrocytes in the epiphyseal (growth) plate proliferate and enlarge, and the cartilage is replaced by bone





- C The periosteum turns into cartilage and stretches
- D Osteoclasts add new bone matrix at the epiphysis
- E Red marrow expands and physically lengthens the bone

16 Which hormonal change is most directly linked to epiphyseal (growth plate) closure during puberty (in both sexes)?



- A Decreased insulin
- B Increased estrogen signaling
- C Decreased thyroid hormone
- D Increased calcitonin only in males
- E Increased aldosterone

17 A 19-year-old with closed growth plates starts a strength program. Over months, their bones can adapt by becoming stronger mainly through:



- A New length growth at the epiphyseal plates
- B Remodeling and appositional growth that changes bone thickness and internal structure
- C Conversion of bone into cartilage to absorb force
- D Immediate doubling of bone cell number by mitosis inside lacunae
- E Bone becoming hollow to increase strength





18 Parathyroid hormone (PTH) is released when blood Ca^{2+} is low. Which set of effects BEST matches the goal of PTH?



- A** Decrease bone resorption, decrease kidney Ca^{2+} reabsorption, decrease vitamin D activation
- B** Increase bone resorption (indirectly), increase kidney Ca^{2+} reabsorption, increase vitamin D activation
- C** Increase bone formation only, with no kidney or gut effects
- D** Decrease intestinal Ca^{2+} absorption, increase urinary Ca^{2+} loss
- E** Increase calcitonin release to lower blood Ca^{2+}

19 Calcitonin is best described (at a basic level) as a hormone that tends to:



- A** Raise blood Ca^{2+} by stimulating osteoclast activity
- B** Lower blood Ca^{2+} by inhibiting osteoclast activity
- C** Raise blood glucose by stimulating glycogen breakdown
- D** Close epiphyseal plates during puberty
- E** Directly insert aquaporins into kidney collecting ducts

20 A child has bowed legs and delayed bone mineralization. Which deficiency is most consistent with this presentation?



- A** Vitamin D deficiency (rickets)
- B** Excess vitamin D
- C** Excess calcitonin
- D** Erythropoietin deficiency
- E** Insulin deficiency as the only cause





21 Which statement **BEST** distinguishes osteoporosis from osteomalacia?



- A Osteoporosis is caused by infection; osteomalacia is caused by viruses.
- B Osteoporosis is reduced bone mass with relatively normal mineralization; osteomalacia is defective mineralization of osteoid.
- C Osteoporosis affects only children; osteomalacia affects only adults.
- D Osteoporosis is too much calcium deposition; osteomalacia is too much collagen deposition.
- E Osteomalacia is caused by too much estrogen; osteoporosis is caused by too much growth hormone.

22 A genetic condition causes osteoclasts to be nonfunctional. Bones become very dense on X-ray, but fracture easily, and the patient develops anemia. Which explanation **BEST** connects these findings?



- A Dense bone always means stronger bone, so fractures cannot happen; anemia is unrelated.
- B Without osteoclasts, bone cannot be formed at all, causing hollow weak bones.
- C Without osteoclast resorption, bone becomes abnormally dense but poorly remodeled and brittle, and marrow cavities can narrow, reducing blood cell production.
- D Osteoclast failure increases red marrow space, causing anemia.
- E Osteoclasts normally produce hemoglobin, so their failure directly causes anemia.

23 In normal bone remodeling, which sequence is most typical at a remodeling site?



- A Osteoblasts deposit new bone → osteocytes digest it → osteoclasts seal the area
- B Osteoclasts resorb bone → osteoblasts form new bone
- C Chondrocytes resorb bone → osteoclasts form bone





- D Platelets form bone → osteoblasts remove it
- E Bone remodeling happens only in childhood, not in adults

24 A person wears a cast and does not use their leg muscles for weeks. Which change is most expected in the immobilized bone (basic principle)?



- A Increased bone density because bones always strengthen when unused
- B Decreased bone density due to reduced mechanical load (disuse), shifting remodeling toward resorption
- C Bone converts to cartilage to keep the leg flexible
- D Growth plates reopen to compensate for immobility
- E Red marrow is completely eliminated immediately

25 Which order best matches the typical stages of fracture healing (simplified)?



- A Remodeling → hematoma → hard callus → soft callus
- B Hematoma (clot) → soft callus → hard callus → remodeling
- C Soft callus → hematoma → remodeling → hard callus
- D Hard callus forms first, then the blood clot appears later
- E Fractures heal mainly by osteocytes dividing to fill the crack overnight

26 Why is the periosteum important in bone repair after a fracture?



- A It contains osteoprogenitor cells and contributes blood supply, helping generate new bone





at the fracture site.

- B It is the main site of red blood cell production in adults.
- C It secretes ADH to reduce urine output during healing.
- D It is made of cartilage that directly turns into muscle.
- E It prevents any remodeling so the fracture stays rigid forever.

27 Which statement about spongy (trabecular) bone is most accurate?



- A It has no blood supply and therefore cannot remodel.
- B It is usually found only in the shaft of long bones.
- C It has a lattice-like structure and often contains red marrow, helping with blood cell production.
- D It is made mostly of cartilage and cannot contain marrow.
- E It is weaker because it has no collagen.

28 The basic structural unit of compact bone is the:



- A Alveolus
- B Nephron
- C Osteon (Haversian system)
- D Sarcomere
- E Axon





29 The central (Haversian) canal of an osteon primarily contains:



- A Cartilage cells and synovial fluid
- B Blood vessels and nerves that supply the bone
- C Air to oxygenate osteocytes directly
- D Bone marrow that produces red blood cells
- E A growth plate that lengthens the bone

30 Which is the BEST overall reason long bones have a medullary (marrow) cavity in the shaft?



- A To store digestive enzymes for the intestine
- B To reduce bone weight while providing space for marrow (fat storage and/or hematopoiesis depending on age/need)
- C To allow growth plates to reopen in adults
- D To provide a place for mitochondria to replicate
- E To prevent blood vessels from entering the bone

31 Why is bone considered a key organ in mineral homeostasis?



- A Because it produces most insulin for the body
- B Because it stores large amounts of calcium and phosphate that can be exchanged with the blood
- C Because it is the main site of oxygen exchange
- D Because it stores glycogen as its main energy reserve
- E Because it removes CO₂ from the blood directly





32 During early fetal development, before bone marrow becomes the main hematopoietic site, blood cell production occurs primarily in the:



- A** Liver and spleen
- B** Pancreas and stomach
- C** Thyroid and parathyroid glands
- D** Skin and hair follicles
- E** Cartilage of the growth plates

33 Which statement about parathyroid hormone (PTH) and bone is MOST accurate at a basic conceptual level?



- A** PTH always increases bone mass regardless of dose and timing.
- B** Continuous high PTH tends to increase bone resorption; carefully timed intermittent PTH can stimulate bone formation more.
- C** PTH acts only on cartilage and never on bone.
- D** PTH lowers blood calcium as its main job.
- E** PTH works by inserting aquaporin channels into the collecting duct.

34 Osteoclasts do not usually have a direct “PTH receptor” that makes them turn on instantly. Instead, PTH most often increases osteoclast activity by acting on osteoblast-lineage cells to increase:



- A** Hemoglobin production
- B** A signal that promotes osteoclast formation/activation (e.g., RANKL)
- C** Insulin secretion into bone matrix





- D Myelin production around osteoclasts
- E Chitin deposition to strengthen bone

35 Which statement about osteocytes is correct?



- A Osteocytes are osteoblasts that became trapped in the bone matrix they secreted.
- B Osteocytes are the same as osteoclasts but smaller.
- C Osteocytes are red blood cell precursors in marrow.
- D Osteocytes form cartilage, not bone.
- E Osteocytes exist only in infants and disappear in adults.

36 A bone marrow transplant can restore production of red cells, white cells, and platelets primarily because it provides:



- A Osteoclasts to rebuild bone
- B Hematopoietic stem cells capable of generating all major blood cell lineages
- C Mature red blood cells that can divide into new blood cells
- D Only antibodies, which then turn into blood cells
- E Calcium crystals to repair marrow DNA

37 As humans age, a common change in bone marrow is:



- A Yellow marrow is progressively replaced by red marrow everywhere.





- B** Red marrow is progressively replaced by yellow (fatty) marrow in many long bones.
- C** Bone marrow is replaced by cartilage in all bones.
- D** Bone marrow disappears entirely in healthy adults.
- E** All marrow becomes red again after puberty ends.

38 A disease replaces much of the red marrow space with non-hematopoietic tissue. Which blood finding is MOST directly expected?



- A** Increased red blood cells, increased white blood cells, increased platelets
- B** Decreased red blood cells, decreased white blood cells, and decreased platelets (reduced overall hematopoiesis)
- C** Only decreased red blood cells; white cells and platelets are unaffected because they are made in the spleen
- D** Only decreased platelets; red blood cells are made in bone matrix
- E** No change in blood counts because marrow is not needed after birth

39 Growth hormone (GH) supports normal height increase mainly by stimulating growth at the epiphyseal plates through:



- A** Increased chondrocyte proliferation and activity (largely via IGF-1)
- B** Immediate mineral dissolution by osteoclasts to lengthen bone
- C** Conversion of bone into cartilage to stretch the skeleton
- D** Stopping chondrocyte division so plates harden early
- E** Direct formation of osteons in the growth plate to extend bone length





40 A new drug strongly inhibits osteoclast activity. In the short term (before long-term compensations), which change is **MOST** consistent with this effect?

- A** Less calcium is released from bone, tending to lower blood Ca^{2+} slightly
- B** More calcium is released from bone, raising blood Ca^{2+} rapidly
- C** Bone formation stops immediately because osteoclasts are the main bone-forming cells
- D** Platelet production increases because osteoclasts make platelets
- E** Epiphyseal plates reopen, allowing adults to grow taller







#	Ans	Answer Text
1	B	Red marrow is the main site of blood cell production; yellow marrow is m...
2	C	Axial skeleton (e.g., pelvis, vertebrae, sternum, ribs) and proximal end...
3	B	B cells mature in bone marrow; T cells mature in the thymus
4	D	Some yellow marrow can convert back toward red marrow to increase hemato...
5	A	Self-renew and give rise to multiple blood cell lineages
6	E	Fragmentation of megakaryocytes in the bone marrow
7	B	Erythropoietin (EPO)
8	B	Osteoblasts: mesenchymal stem cells; Osteoclasts: hematopoietic/monocyte...
9	D	Osteoclast
10	A	Osteocyte
11	A	Secretion of osteoid (collagen-rich matrix) that later mineralizes
12	B	Appositional growth: osteoblasts add new bone on the periosteal surface
13	B	Bone forming by replacing a cartilage model with bone tissue
14	B	Many flat bones of the skull (and parts of the clavicle)
15	B	Chondrocytes in the epiphyseal (growth) plate proliferate and enlarge, a...
16	B	Increased estrogen signaling
17	B	Remodeling and appositional growth that changes bone thickness and inter...
18	B	Increase bone resorption (indirectly), increase kidney Ca^{2+} reabsorption...
19	B	Lower blood Ca^{2+} by inhibiting osteoclast activity
20	A	Vitamin D deficiency (rickets)
21	B	Osteoporosis is reduced bone mass with relatively normal mineralization;...
22	C	Without osteoclast resorption, bone becomes abnormally dense but poorly ...
23	B	Osteoclasts resorb bone → osteoblasts form new bone
24	B	Decreased bone density due to reduced mechanical load (disuse), shifting...
25	B	Hematoma (clot) → soft callus → hard callus → remodeling
26	A	It contains osteoprogenitor cells and contributes blood supply, helping ...
27	C	It has a lattice-like structure and often contains red marrow, helping w...
28	C	Osteon (Haversian system)
29	B	Blood vessels and nerves that supply the bone
30	B	To reduce bone weight while providing space for marrow (fat storage and/...
31	B	Because it stores large amounts of calcium and phosphate that can be exc...
32	A	Liver and spleen
33	B	Continuous high PTH tends to increase bone resorption; carefully timed i...
34	B	A signal that promotes osteoclast formation/activation (e.g., RANKL)
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