Pathology

Bone Tumors

Learning outcomes:

By the end of the lecture, You will be able to:

- Identify primary and secondary bone tumors
- Describe gross and microscopic pictures of major bone tumors
- Discuss the clinical presentation, radiology, diagnosis and prognosis of bone tumors

Agenda

A) Primary bone tumors:

1- Bone-forming tumors (osteogenic)

2- Cartilage-forming tumors (chondrogenic)

3- Fibrohistiocytic tumors

4-Tumors of unknown origin

5-Hematopoietic tumors

B) Secondary bone tumors (metastatic tumors)

1-Bone forming tumors

Benign

*Osteoma

*Osteoid osteoma

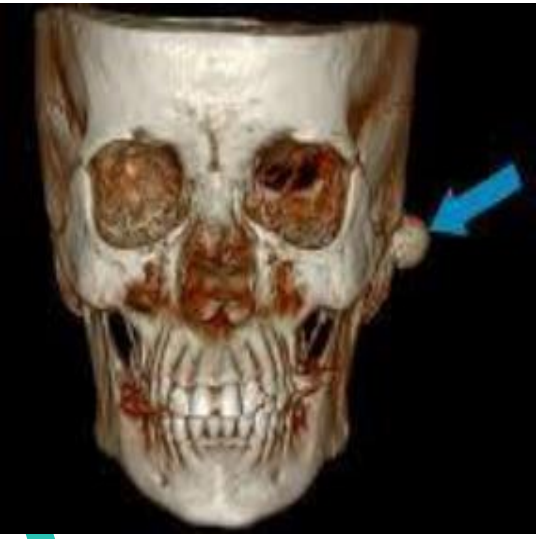
* Osteoblastoma

Malignant

*Osteosarcoma

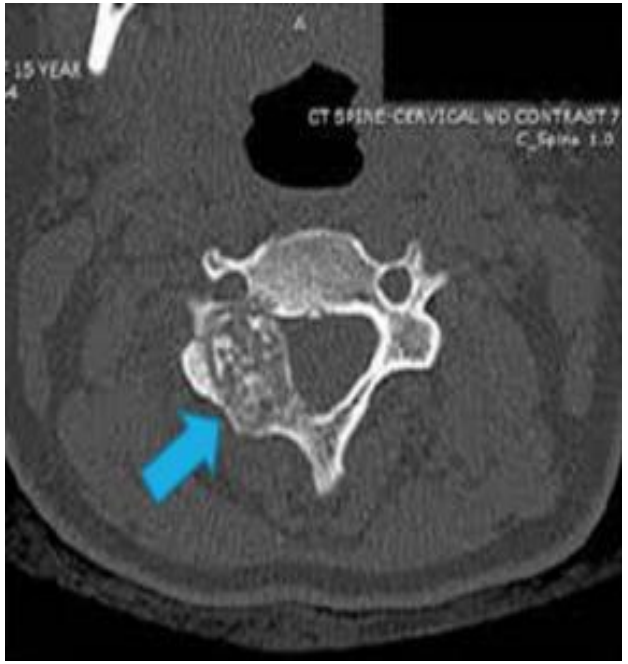
1-Bone forming tumors

Osteoma
Benign, 40-50y



Osteoid Osteoma
Benign,10-30y

Osteoblastoma
Benign,10-30y



Osteosarcoma
Malignant, 10-20y

Osteoma

Age: Adults

Site: Facial bones(skull, jaws & paranasal sinuses)

Number: Single or multiple

Clinical picture: Local mechanical problems as:

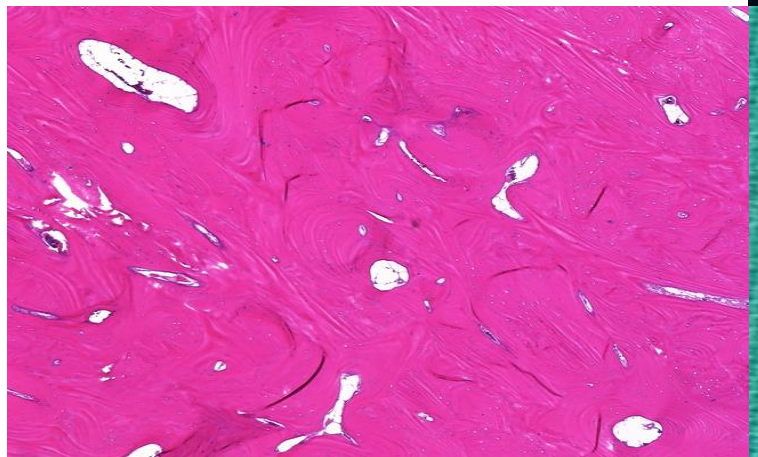
*Sinus obstruction.

*Visual defects and

*Cosmetic deformity.

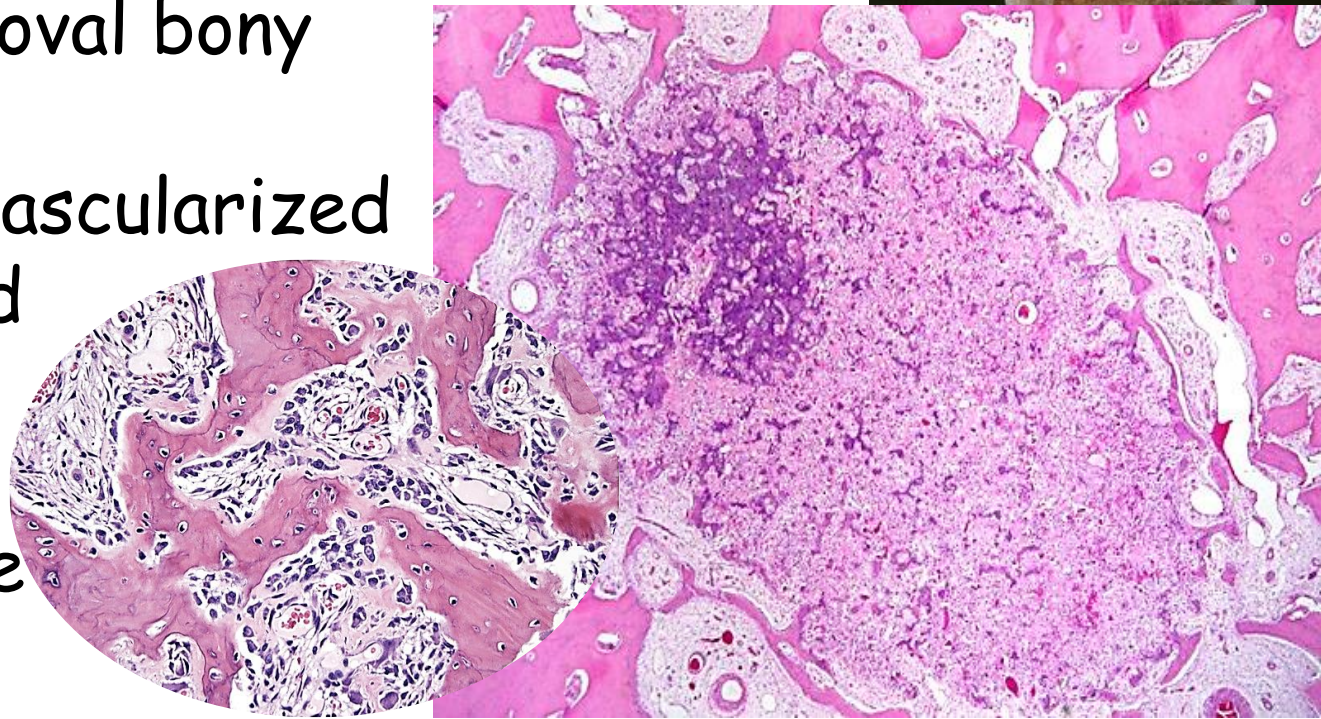
NE: Well circumscribed round or oval bony mass, white and firm attached to bone cortex

ME: Admixture of mature lamellar and woven bone patterns.



Osteoid Osteoma

Age: Adults
Site: metaphysis of long bone
Clinical picture: Severe pain (tumor cells secrete Prostaglandin E2) relieved by aspirin.
Radiology: Radiolucent center (nidus) surrounded by dense sclerotic bone
NE: Well circumscribed round or oval bony mass in the cortex.
ME: *Central nidus is formed of vascularized fibroconnective tissue surrounded by Interlacing trabeculae of Woven Bone lined by osteoblasts
*Periphery of dense reactive bone (sclerosis)



Osteoblastoma

Similar to osteoid osteoma

Site: vertebrae

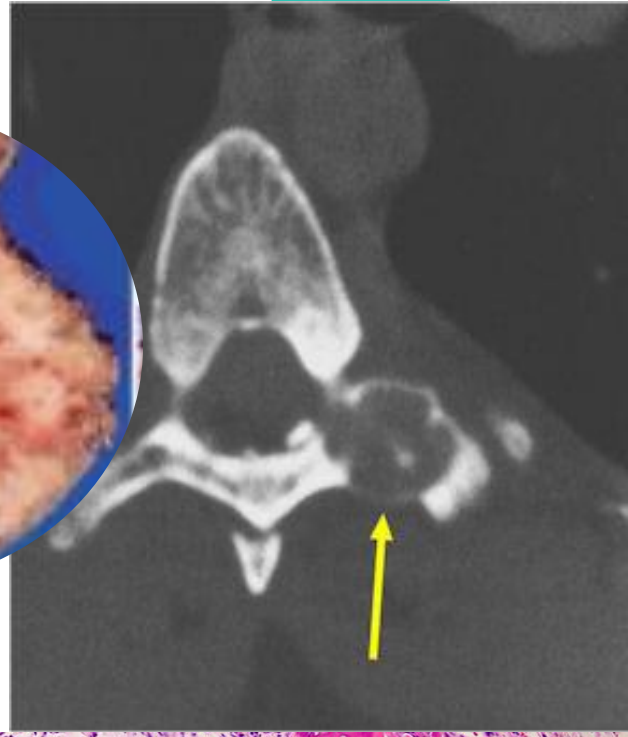
Clinical picture: Less pain

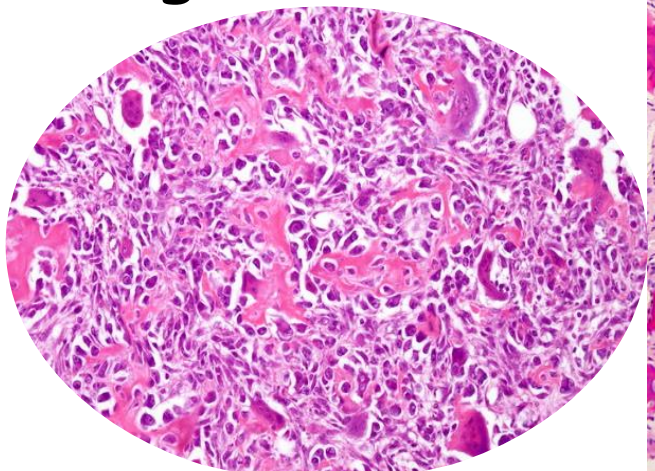
Radiology: Radiolucent larger size (>2 cm)

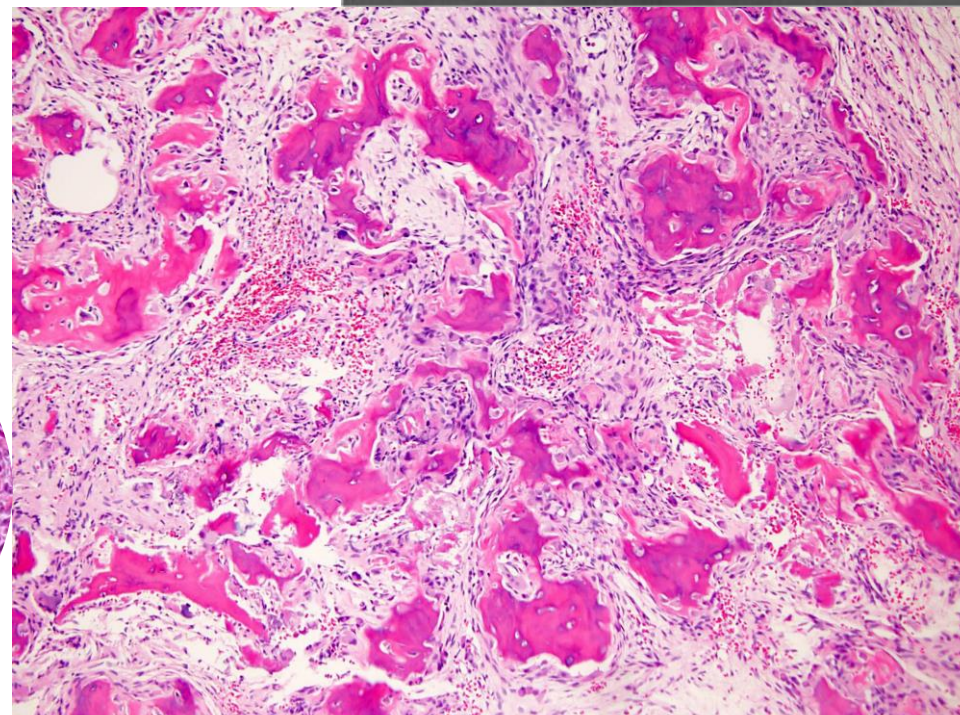
ME:

*Nidus: osteoid bone prominently lined by osteoblasts + highly vascular C.T. stroma, and multinucleated giant cells.

*Absent or minimal surrounding sclerosis (reactive bone).







Osteosarcoma

The most common primary malignant tumor of bone.

Primary Osteosarcoma

- Age: <20y.
- Location: Metaphysis of long bones of
- Genetic factors: Mutations of: RB1 (retinoblastoma-1) gene, TP53

Secondary Osteosarcoma

- Age: > 40y.
- Location: at the site of predisposing factor.
- Predisposing factors:
  -Paget's disease of bone.
  -Bone irradiation

C/P: Pain
Pathological fracture
Aggressive behaviour, recurrence.
Direct spread and early blood spread to the lungs.

Osteosarcoma

- Radiology:

Destructive, mixed lytic and sclerotic mass with infiltrative margins with characteristic sunray appearance and Codman triangle

Osteosarcoma

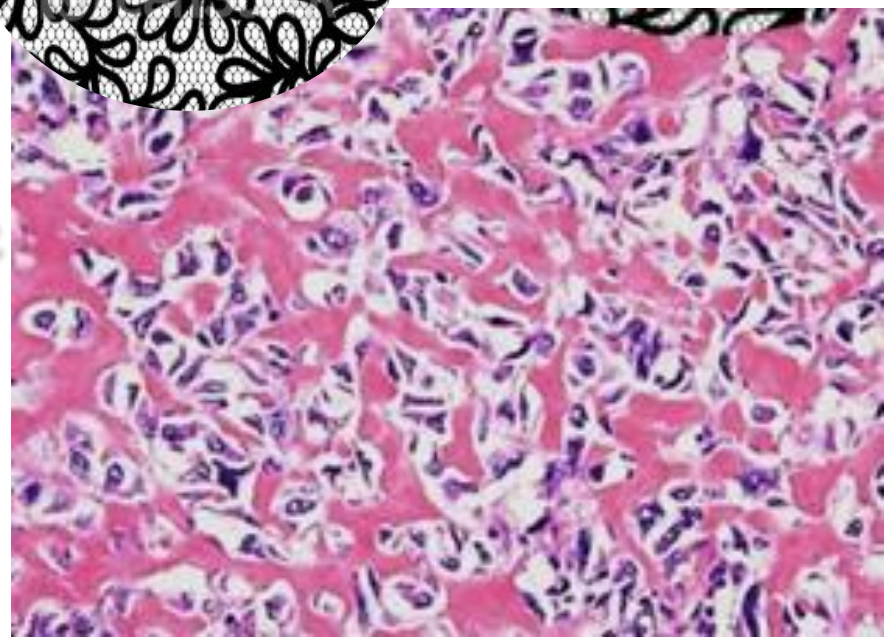
NE:

Fusiform mass with hemorrhage and necrosis which occupies the medullary cavity then passes to the bone cortex, and elevates the periosteum, may infiltrate soft tissue around

ME:

Direct deposition of osteoid matrix (glassy eosinophilic) by tumor cells in a lace-like pattern is diagnostic.

- Malignant osteoblasts (pleomorphism, large hyperchromatic nuclei, mitosis).
- Bizarre and giant tumor cells and abnormal mitotic figures



2-Cartilage forming tumors

Benign

*Osteochondrma

*Chondroma

Malignant

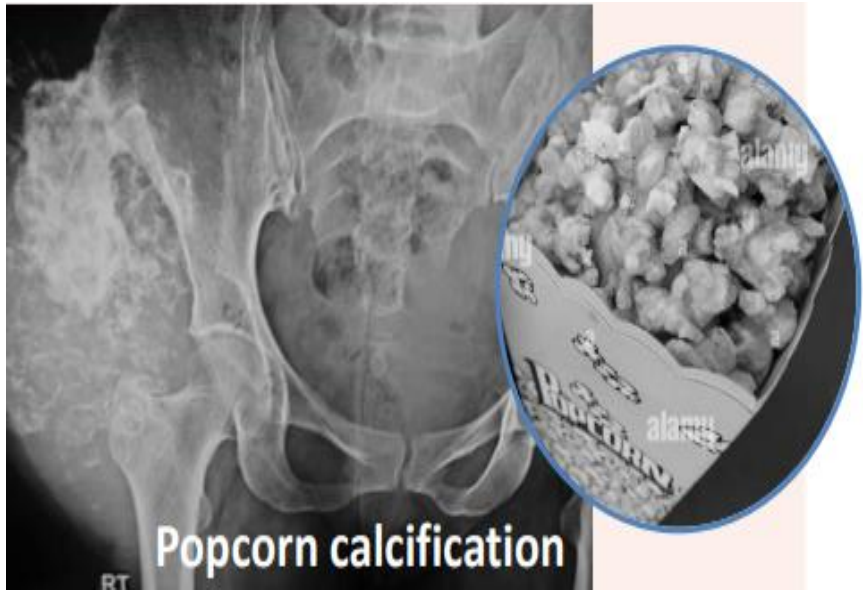
*Chondrosarcoma

2-Cartilage forming tumors

Osteochondroma
Benign,10-30y

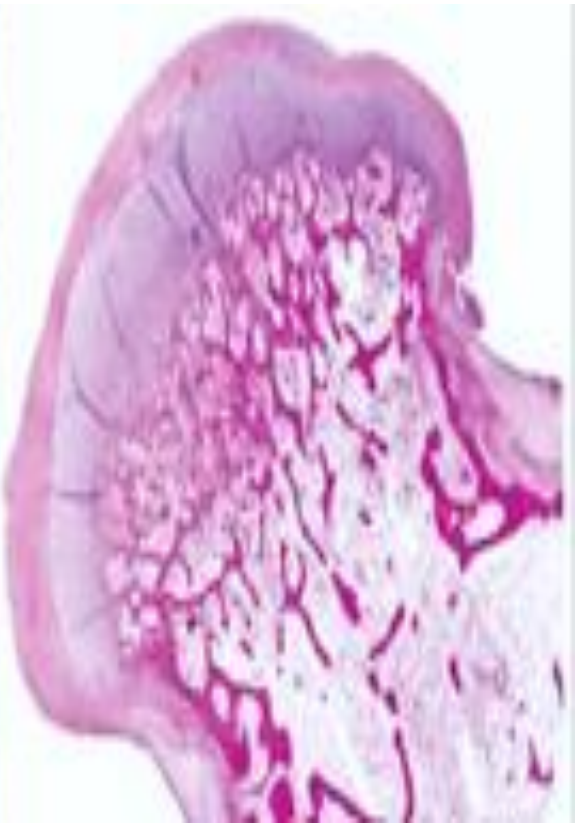
Chondroma
Benign,10-30y

Chondrosarcoma
Malignant, 30-60y



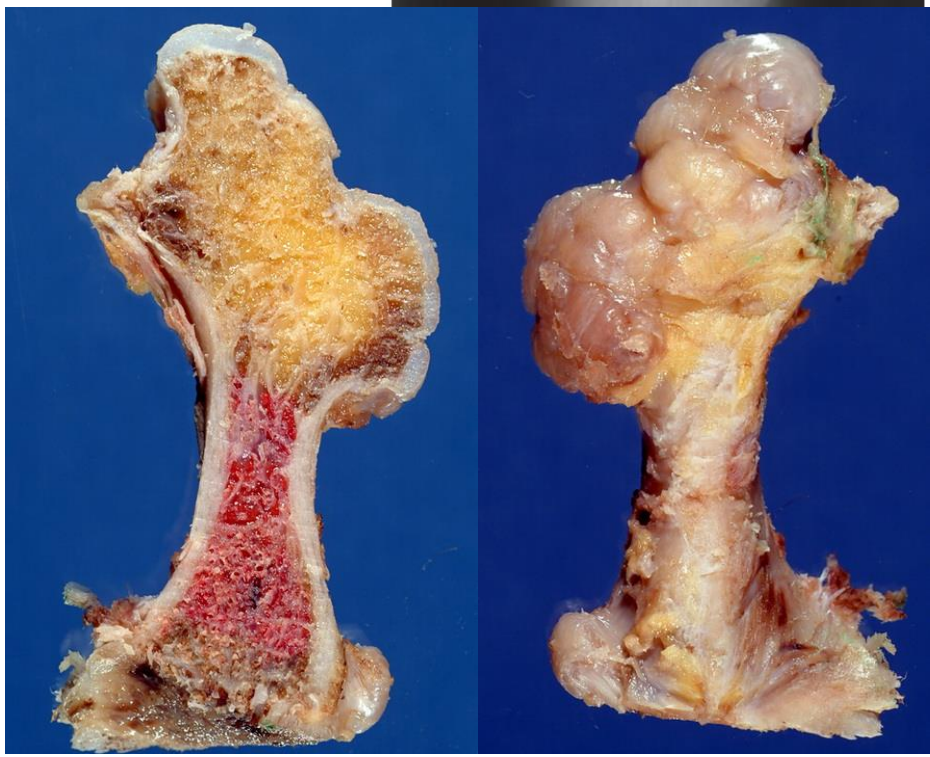
Osteochondroma (exostosis)

- Osteochondroma is a benign cartilage-capped tumor that is attached to the underlying skeleton by a bony stalk.
- **Age**:10-30 years
- **Site**: Metaphysis of long bone especially around the knee
- **Number**: Most are solitary, multiple in multiple hereditary exostosis syndrome
- **Clinical picture**: Slowly growing mass, may be painful if fractured or compressed nerve



Osteochondroma (exostosis)

- **NE**: sessile or pedunculated mass, and they range in size from 1 to 20 cm.
- **ME**: Cap of mature hyaline cartilage with underlying bone trabeculae separated by bone marrow



Chondroma

Usually occur in bones of endochondral origin.

Age: 10-30 years

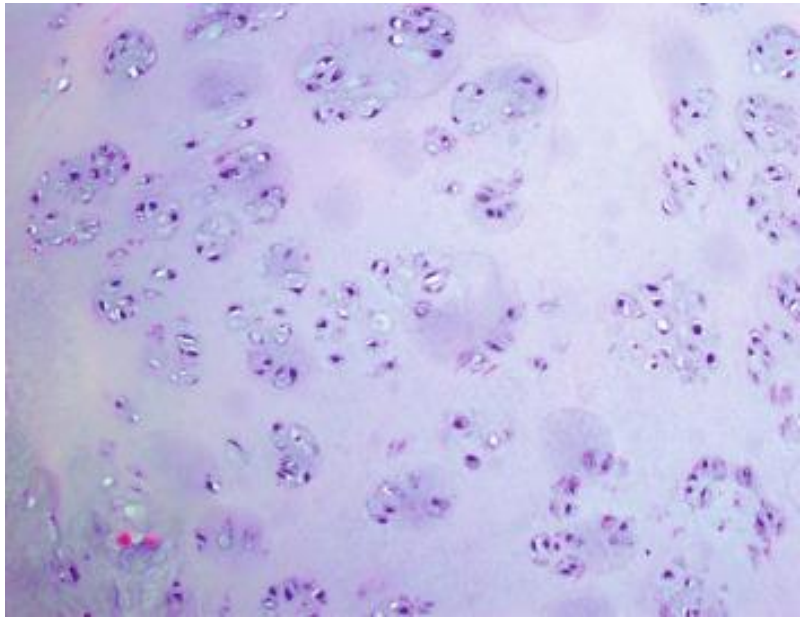
Site: Medullary cavity of small bones of hands and feet

Number: Solitary , can be multiple in syndromes

Clinical picture: Asymptomatic or can produce pain or deformity, may turn malignant

NE: chondromas are usually smaller than 3 cm and are gray blue and translucent

ME: Composed of well-circumscribed nodules of hyaline cartilage containing benign chondrocytes



Chondrosarcoma

The second most common primary malignant tumor of bone.

Primary Chondrosarcoma

- Location:
  - Central (in the medullary cavity)
  - Peripheral (on the surface of the bone).
- Genetic factors: Mutations of: IDH1 and IDH2.

Secondary Chondrosarcoma

- Secondary (to osteochondroma or enchondroma).

C/P: Pain
Pathological fracture
Recurrence.
Direct spread and early blood spread to the lungs.

Chondrosarcoma

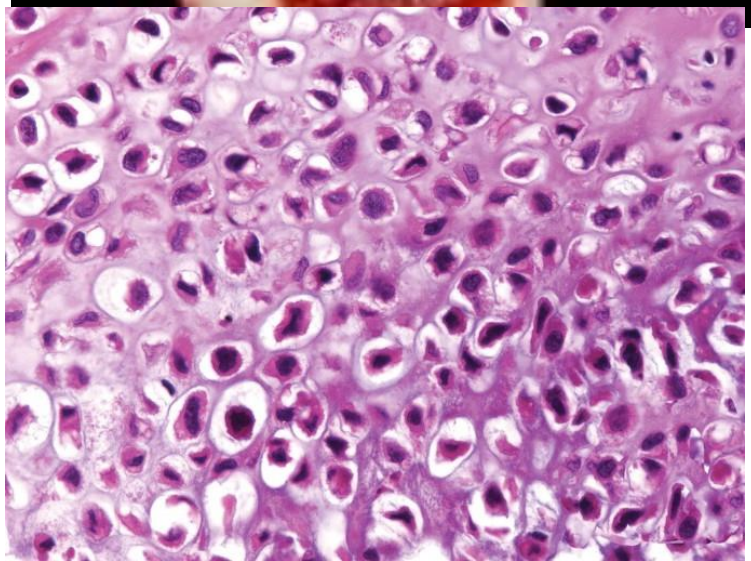
Age:30-60 years

Site: Pelvis, shoulder and ribs

Radiology: Large mass with "Popcorn calcification".

NE: large bulky nodules of glistening, translucent cartilage with spotty calcifications and necrosis.

ME: Malignant chondrocytes with pleomorphism and increased mitotic figures in a chondroid matrix infiltrating the bone marrow with entrapment of normal bony trabeculae.



Now....Answer this

Which of the following is true about osteoid osteoma?

a)Affects facial bones.

b)Occurs in children.

c)It is formed entirely of lamellar bone.

d)It is malignant bone tumor.

e)Affects long bones.

3-Tumors of Unknown Origin

Locally aggressive

*Giant cell tumor

Malignant

*Ewing sarcoma

Giant Cell Tumor

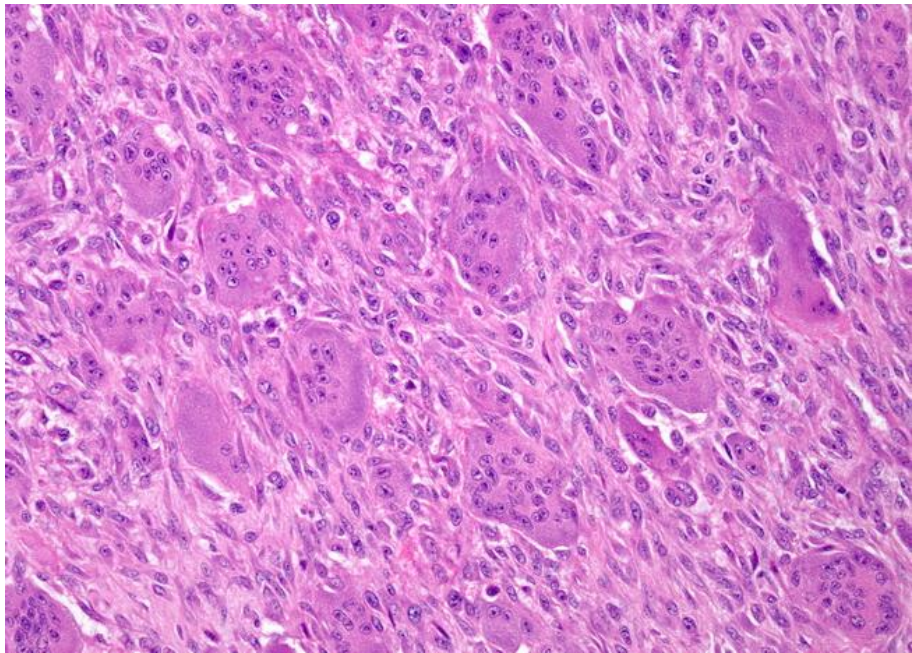
Age : Adults (20-40 years)

Site: Epiphysis of long bones (distal femur and proximal tibia)

Radiology: Expanding lesion Soap Bubble appearance

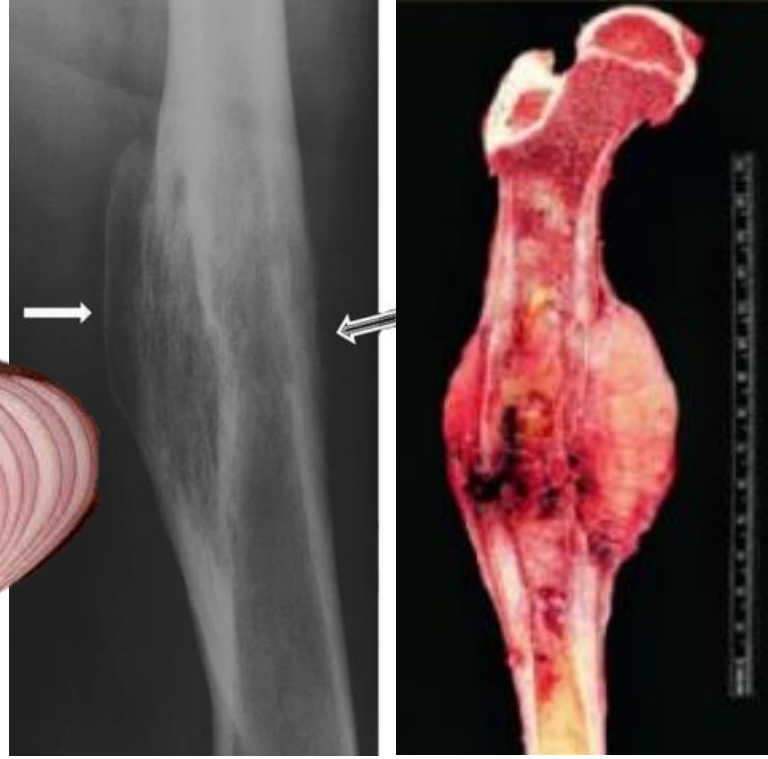
Clinical picture: Pain, pathologic fracture, Arthritis like symptoms as, if close to joint

- **ME**: consisting of numerous osteoclast-type giant cells with 100 or more nuclei with uniform, oval mononuclear tumor cells in between. The tumor lacks bone or cartilage



Ewing Sarcoma

Ewing sarcoma called **primitive neuroectodermal tumor (PNET).** The second most common bone sarcoma in children



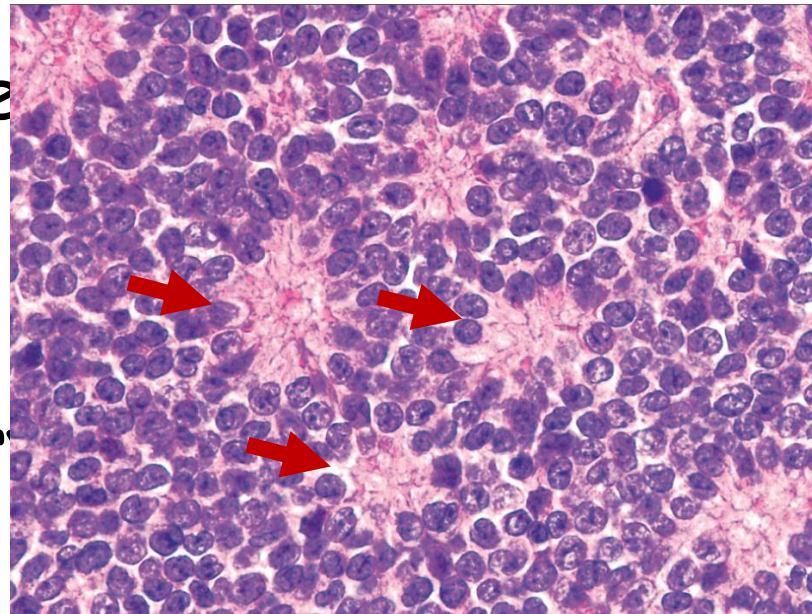
Age :10-20 years

Site: Diaphysis of long bone

Clinical picture: painful enlarging masses

Pathogenesis: EWSR and FLI1 mutations

Radiology: destructive lytic tumor with reactive bone deposited in an **onion-skin fashion**

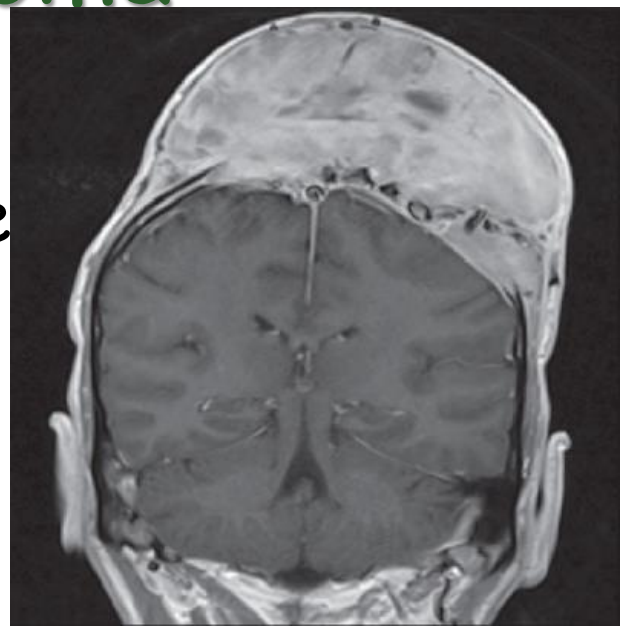


ME: Sheets of uniform small, round cells that have scant cytoplasm. **Homer-Wright rosettes** (round groupings of cells with a central fibrillar core) may be present.

4- HematopoieticTumors

Plasma cell myeloma
(multiple myeloma)

Plasmacytoma / Multiple Myeloma



Proliferation of neoplastic plasma cells in the bone marrow which leads to lytic lesion/lesions in the bone

*One lytic lesion = Plasmacytoma (solitary myeloma)
*Multiple lytic lesions = Multiple myeloma

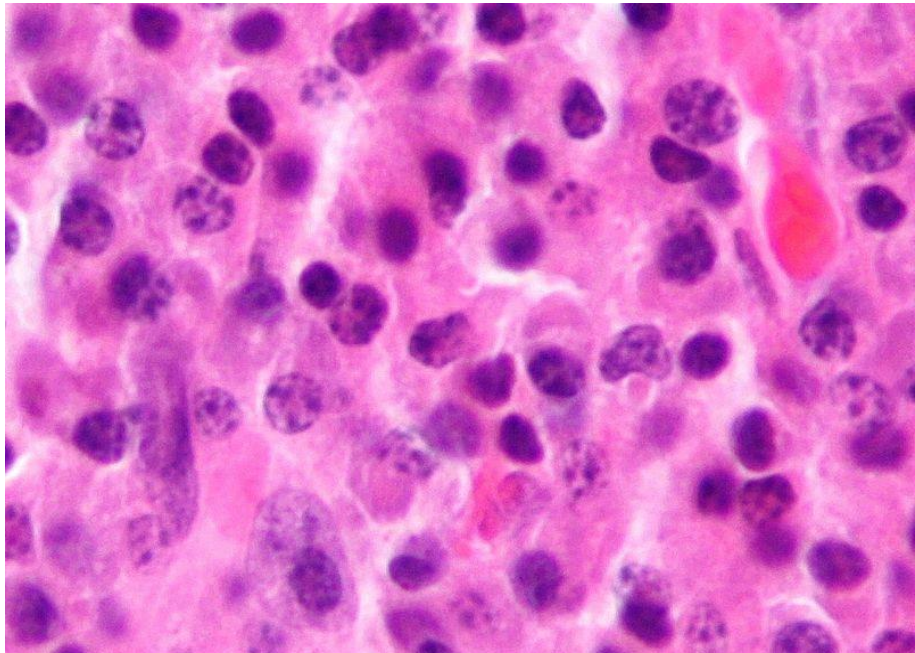
Age: old age

Site :Skull, vertebrae, ribs, pelvis, long bone.

Clinical picture:

- Solitary plasmacytoma: Pain
- Multiple myeloma: **CRAB**: hypercalcemia, renal impairment, anemia and bone fracture

ME: Plasma cells in sheets, sometimes with prominent nucleoli or inclusions containing immunoglobulin



Secondary Bone Tumors

More common than primary.

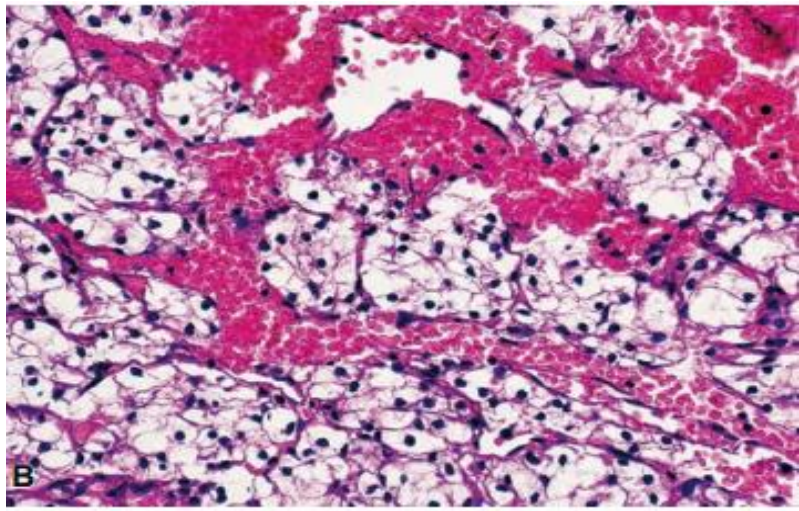
Reach bone by blood

Primary sites are breast, prostate, lung, thyroid and kidney.

Most bone metastases are *osteolytic (produce bone destruction) except cancer prostate that may be *osteosclerotic (tumor secrete factors stimulate osteoblasts).

Age: Adults

Sites: Multifocal in axial skeleton and proximal part of appendicular skeleton (due to presence of vascular red marrow)



Now….Answer this

What are the neoplastic cells in multiple myeloma?

a)Plasma cells.

b)Osteoblasts.

c)Fibroblasts.

d)Endothelial cells.

e)Epithelial cells.

Summary

A) Primary bone tumors:

1- Bone-forming tumors (osteogenic)

2- Cartilage-forming tumors (chondrogenic)

3- Fibrohistiocytic tumors

4-Tumors of unknown origin

5-Hematopoietic tumors

B) Secondary bone tumors (metastatic tumors)

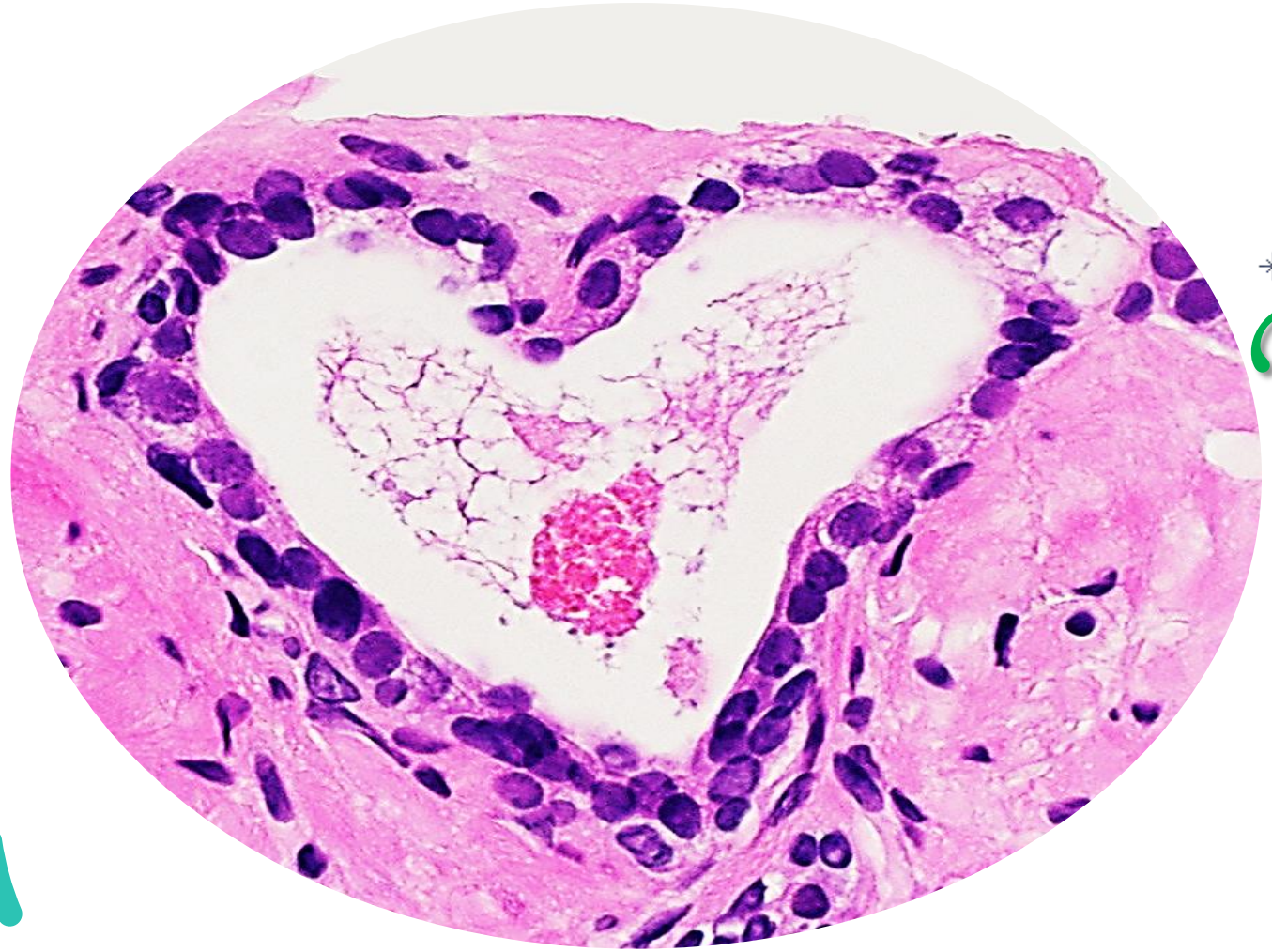
Discussion & Feedback

References & recommended readings

1. Robbins & Cotran Pathologic Basis of Disease, (Robbins Pathology), 2018 ISBN: 978-0-323-35317-5, Edition: 10th
2. Webpath:

   https://webpath.med.utah.edu/webpath.html

   https://www.pathologyatlas.ro/index.php



Thank you