

Benign Tumors and Tumor-like Lesions

Pediatric pathology: conceptual classification, morphology and clinical relevance

Dr Abu Suraih Sakhri

MBBS, MD (Pathology)

www.abusuraihsakhri.com

Learning outcomes

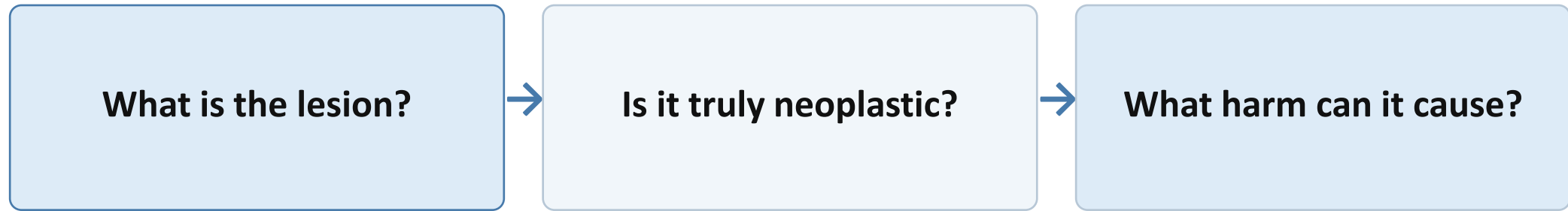
- Distinguish true benign tumors, hamartomas and heterotopias using tissue identity and architecture.
- Differentiate pediatric vascular tumors from vascular malformations and recognize their clinical behavior.
- Relate fibrous lesions and teratomas to morphology, molecular findings and risk.

Classification → morphology → biological behavior → clinical consequence

Why the pediatric context matters

- Tumor-like developmental masses are especially important mimics of neoplasia in infants and children.
- Benign pediatric tumors outnumber childhood malignant tumors in the chapter's overview.
- Benign morphology does not exclude major clinical problems caused by size or location.

Two different questions about a mass



- Identity, clonality and architecture address classification.
- Site, size and functional effects address clinical risk.

Pediatric versus adult tumor patterns

Pediatric context	Adult context
Common childhood solid neoplasms emphasize mesenchymal soft tissue origin.	The chapter contrasts this with frequent epithelial tumors in adults.
Developmental tumor-like lesions are an important diagnostic problem.	This pediatric developmental context is less prominent in the overview of adult tumors.
Behavior often requires age- and entity-specific interpretation.	Adult morphologic analogies may mislead for some pediatric tumors.

The comparison is qualitative; No frequency estimate is implied.

Three groups warrant particular attention

Vascular lesions

Proliferative vascular tumors and nonproliferative vascular malformations.

Fibrous lesions

Fibroblastic or myofibroblastic proliferations with variable cellularity and behavior.

Teratomas

Germ-cell tumors where tissue maturity contributes to risk assessment.

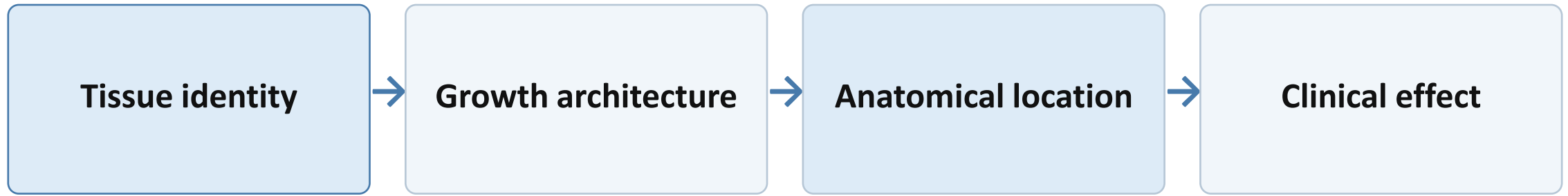
These are the three groups singled out by Robbins in the overview.

A lesion can be benign yet clinically serious

- Mass effect can disrupt organ function despite bland histology.
- Exposed sites may cause a prominent cosmetic or structural concern.
- The lesion's trajectory—growth, stability or involution—changes clinical interpretation.

Severity depends on behavior and anatomy, not only malignant potential.

Reasoning from morphology to consequences



- A familiar tissue type may still be abnormal in its position.
- Consider functional compromise even when malignant features are absent.

Developmental mimics and true neoplasms

Heterotopia

Normal differentiated tissue located outside its usual anatomical site.

Hamartoma

Focal overgrowth of the tissue elements native to an organ, in disordered arrangement.

Neoplasm

An autonomous proliferative lesion; May be benign or malignant.

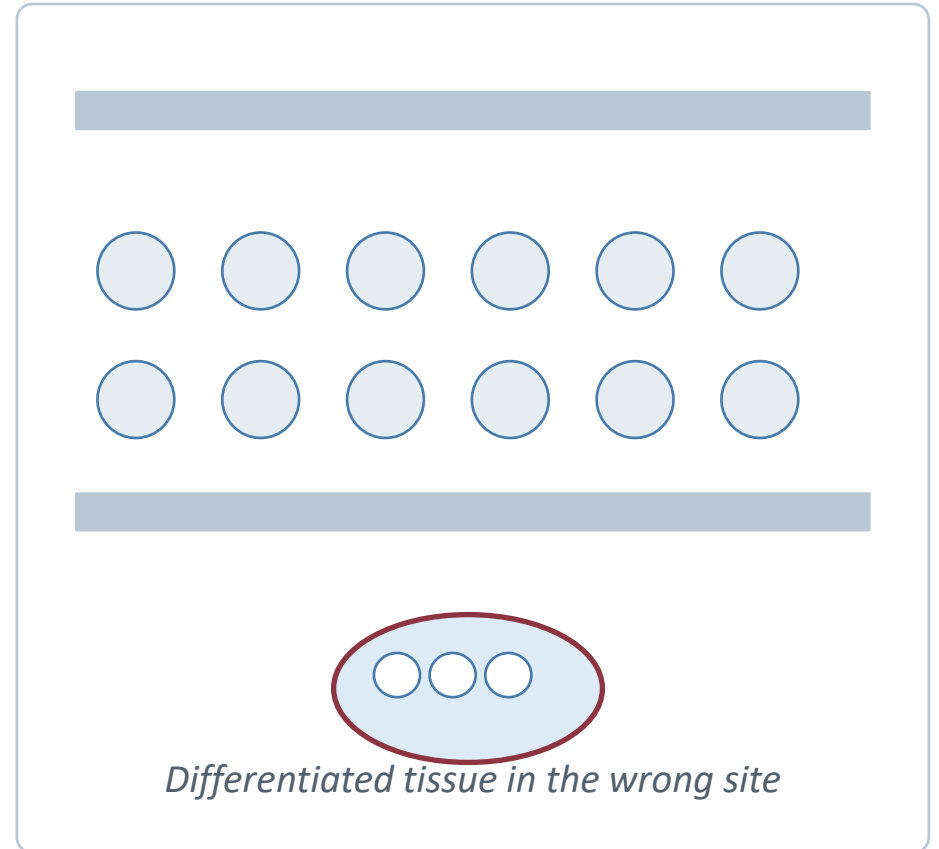
The boundary between hamartoma and benign neoplasm is not always absolute.

Diagnostic questions for a childhood mass

- Are the cells native to this organ or located ectopically?
- Is the microscopic tissue arrangement preserved or disordered?
- Does the lesion proliferate, remain stable or regress?
- Could an important structure be compromised by the mass?

Heterotopia: Tissue in the wrong location

- Differentiated, microscopically normal tissue appears at an abnormal site.
- The term choristoma is a synonym.
- The primary abnormality is location, not necessarily cytologic atypia.



Heterotopia is not defined by malignancy

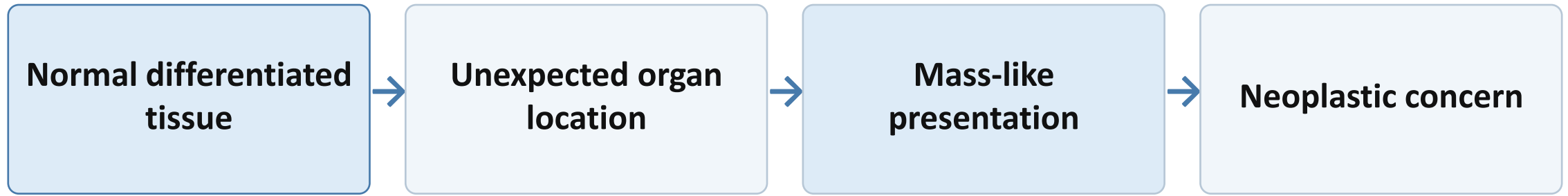
Property	Interpretation
Tissue differentiation	Microscopically normal or mature tissue.
Anatomical position	Outside the site where that tissue normally resides.
Clinical mimic	A focal rest or mass may resemble a neoplasm clinically.
Usual significance	Generally minor, although rare neoplasms can arise in rests.

Pancreatic heterotopia: A concrete example

- A pancreatic tissue rest can be present in the gastric wall.
- The same heterotopic tissue can occur in the wall of the small intestine.
- Identification depends on tissue type plus the unexpected anatomical site.

An ectopic rest can be mistaken for a mass arising from the host organ.

How heterotopia becomes a diagnostic mimic



- Appearance as a discrete lesion does not prove true neoplasia.
- Histology can clarify tissue identity and relationship to the host site.

Adrenal rests: Examples of ectopic location

- Adrenal cortical cells may be present within the kidney.
- Adrenal rests are also described in the lung and ovary.
- These rests should be recognized as ectopic adrenal tissue, not automatically as a primary tumor of the host organ.

Interpret an ectopic adrenal rest

Illustrative scenario: Mature adrenal-type tissue is detected within an ovarian lesion.

Question

What classification should first be considered?

Reasoned interpretation

A heterotopic adrenal rest: The tissue identity is preserved but its location is ectopic.

If an actual neoplasm arises there, reclassify the new proliferation on its merits.

Rare neoplasia arising in heterotopic rests

- Most ectopic rests have little clinical significance.
- A genuine neoplasm can occasionally originate within the heterotopic tissue.
- The possibility with adrenal cortical carcinoma arising in the ovary.

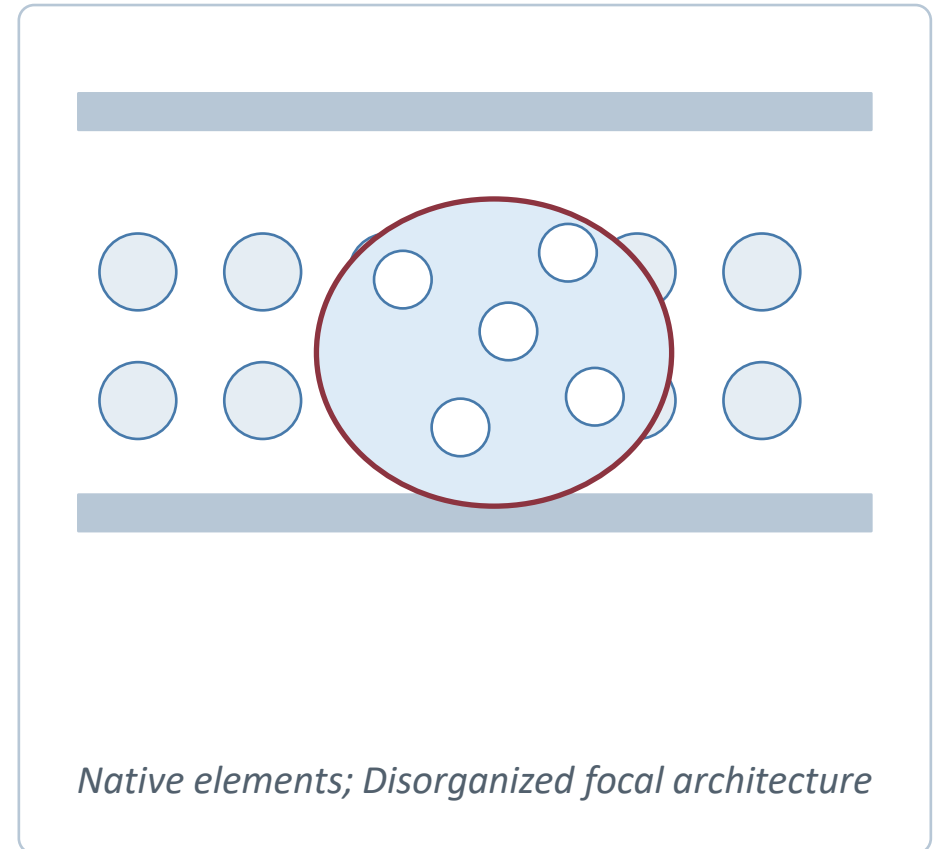
Rare transformation does not make all ectopic rests premalignant.

Heterotopia versus a primary host-organ mass

Observation	Why it matters
Mature cells matching another organ	Supports a heterotopic rest when found ectopically.
Mass in stomach or bowel wall	A pancreatic rest is among the possible explanations.
Mass in ovary with adrenal-type tissue	Consider ectopic adrenal tissue.
Evidence of a new neoplastic proliferation	A rare secondary neoplasm may arise within an ectopic rest.

Hamartoma: Native tissues, abnormal arrangement

- A hamartoma is a focal excessive growth of elements native to the involved organ.
- The component cells are mature and resemble those elsewhere in that organ.
- Their spatial organization differs from the normal surrounding tissue.



Architecture separates two developmental patterns

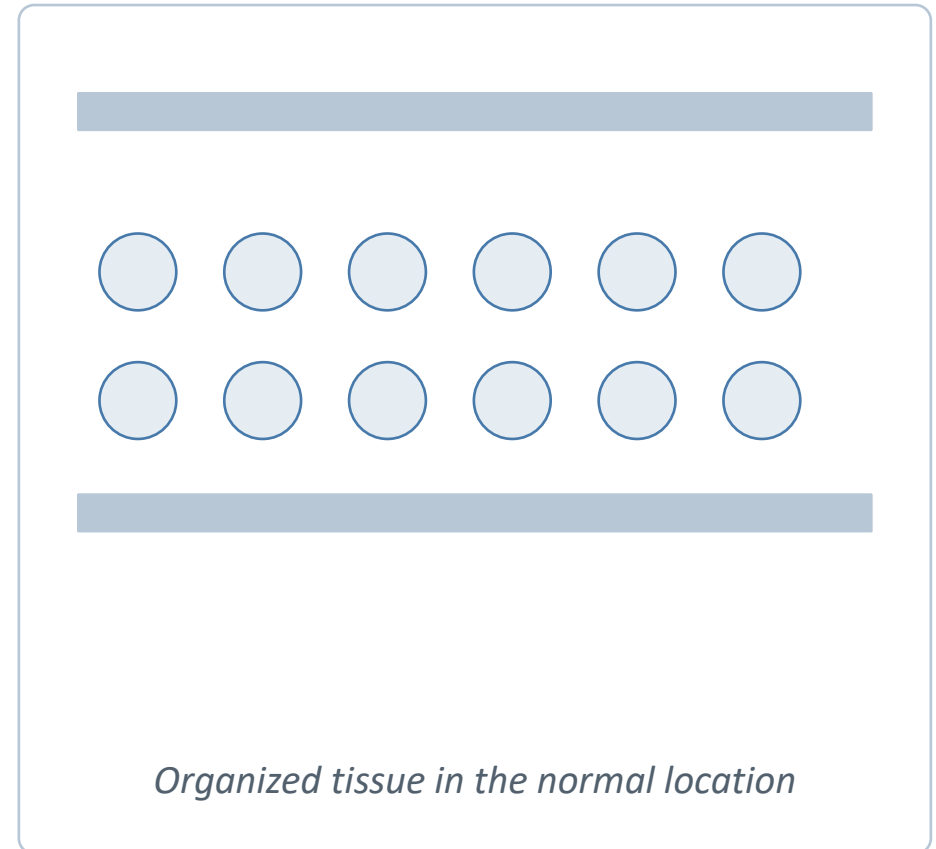
Heterotopia	Hamartoma
A normal tissue type appears in a location where it does not belong.	Elements are native to the organ where the mass occurs.
Anatomical location is the defining abnormality.	Excess and disorganization of native elements are central.
Example: pancreatic tissue within gastric wall.	Examples may include selected vascular, cardiac or cystic lesions.

Why architecture matters in hamartomas

- Mature cells alone do not imply a normally formed organ structure.
- A benign collection can distort the normal spatial relationships of tissue components.
- The diagnosis requires considering both cellular identity and architecture.

Normal architecture as a hamartoma comparator

- Outside the lesion, native tissue shows an expected architectural pattern.
- The focus contains similar differentiated tissue components.
- Local overgrowth produces a disordered, mass-forming arrangement.



Hamartoma and neoplasm are not mutually exclusive labels

- The demarcation between a hamartoma and a benign tumor can be indistinct.
- Both categories may display clonality.
- Clonal growth alone should not be used to redefine every hamartoma as a malignant lesion.

Classification requires integrating developmental and proliferative features.

Examples with debated classification

Vascular

Hemangiomas and lymphangiomas may be interpreted differently by authors.

Solid organ

Cardiac rhabdomyoma and hepatic adenoma are among lesions discussed in this context.

Developmental cysts

Cysts in kidney, lung and pancreas may be interpreted as hamartomatous in some settings.

These are examples of classification ambiguity, not universal categorical diagnoses.

Cardiac rhabdomyoma as a classification example

- Rhabdomyoma of the heart among lesions interpreted variably as hamartoma or true neoplasm.
- The defining teaching problem is classification, not a claim that every cardiac rhabdomyoma is a hamartoma.
- The organ-specific lesion requires its own focused pathology assessment.

Lymphangioma and vascular lesion terminology

- A lymphangioma may be described as a hamartomatous lesion in some classifications.
- Vascular tumor and vascular malformation terminology also overlaps clinically.
- Avoid applying a universal label before establishing the relevant lesion subtype.

Terminologic uncertainty is explicitly acknowledged by Robbins.

Developmental cysts and the hamartoma spectrum

- Developmental cysts in kidney, lung and pancreas are included as possible hamartomatous processes.
- Their organ-native elements distinguish them conceptually from heterotopic rests.
- An organ-specific differential diagnosis remains necessary; The broad label is insufficient.

Hamartoma reasoning exercise

Illustrative scenario: A well-differentiated focal mass contains tissues native to the organ, but their architecture is disorganized.

Question

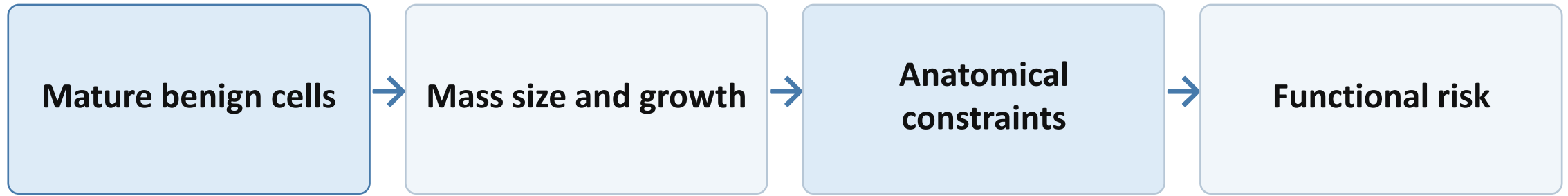
Which descriptive category fits these features?

Reasoned interpretation

Hamartoma is a reasonable descriptive classification. Its distinction from benign neoplasm may remain blurred.

An apparently benign lesion can still cause clinical problems through size or site.

Why benign histology does not settle management



- Risk and morphology provide different pieces of information.
- Robbins specifically cautions that benign lesions may rarely be life-threatening.

Framework for pediatric vascular masses

Proliferative tumor

Mass-forming vascular lesion with a proliferative component.

Vascular malformation

A structurally abnormal vascular lesion classified as nonproliferative.

Terminology challenge

Clinical labels may not consistently reflect this biological distinction.

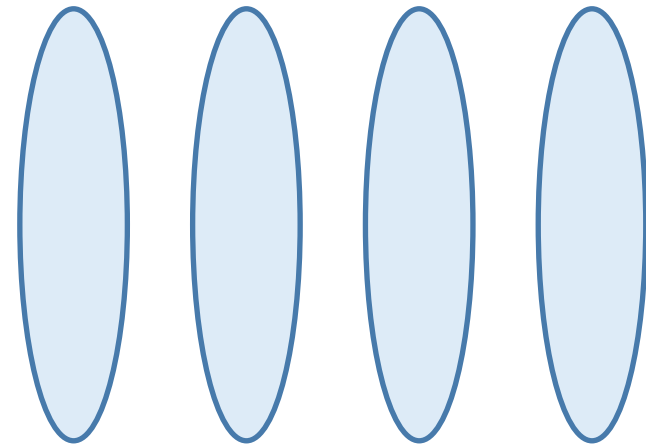
Do not equate every flat red-blue skin lesion with a proliferative hemangioma.

Vascular tumors versus vascular malformations

Feature	Vascular tumor	Vascular malformation
Concept	Proliferative vascular lesion.	Nonproliferative vascular anomaly.
Hemangioma label	Strictly refers to benign vascular tumors.	Sometimes applied imprecisely to malformations.
Clinical differentiation	Can be difficult by appearance alone.	Can be difficult by morphology alone.
Teaching emphasis	Consider lesion growth pattern.	Consider abnormal vessel architecture.

What a vascular lesion diagram can—and cannot—show

- Vascular lesions comprise mass-forming abnormalities of vessels.
- The diagram illustrates channels only; It does not establish a diagnosis.
- Clinical evolution and formal classification are needed beyond the vessel outline.



Schematic vascular channels; Not a micrograph

The hemangioma naming pitfall

- In strict usage, hemangioma denotes a benign vascular neoplasm.
- In less precise usage, the same word is applied to certain vascular malformations.
- Document the intended biological category instead of relying solely on the label.

A naming error can obscure proliferative versus nonproliferative biology.

Vascular masses dominate infant mass-forming lesions

- Vascular lesions as the most common mass-forming lesions of infancy.
- Their broad vascular architecture is not fundamentally different from that seen in adults.
- The pediatric emphasis is distribution, evolution and consequences.

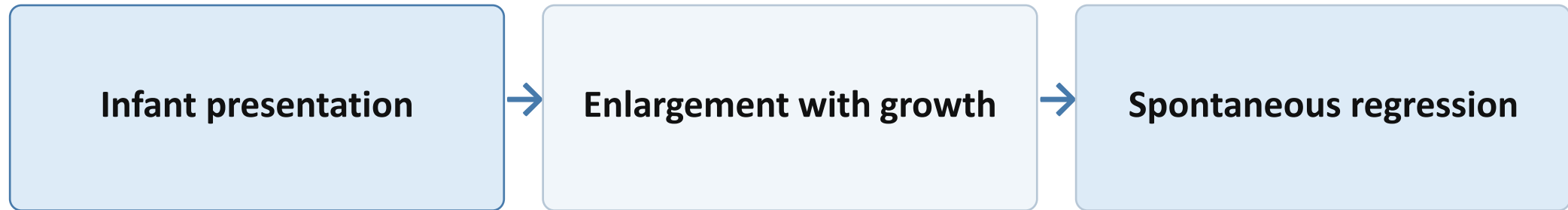
Common cutaneous locations and appearance

- Most childhood vascular lesions described here are in the skin.
- Face and scalp are prominent sites.
- They may be flat or elevated, irregular, and red to blue in appearance.

Recognizing flat and elevated lesions

Flat vascular lesion	Elevated vascular mass
May present as a broad superficial discoloration.	Produces an appreciable mass above the cutaneous surface.
Some large flat lesions are called port-wine stains.	Some vascular tumors enlarge and later regress.
Surface appearance alone does not resolve exact biological category.	Growth behavior remains an important part of interpretation.

The natural history may include involution



- Some hemangiomas grow in parallel with the child.
- Many lesions regress spontaneously; The source figure illustrates this.

Regression is common in some lesions, not guaranteed for every vascular malformation.

Clinical importance beyond appearance

- Cutaneous vascular lesions may have substantial cosmetic consequences.
- A large or strategically located mass may create functional concerns.
- The presence of a vascular lesion can sometimes be part of a hereditary condition.

Syndromic and familial associations

- Von Hippel–Lindau disease as an example of a hereditary association relevant to vascular lesions.
- A subset of central nervous system cavernous vascular malformations is familial.
- The familial CNS cavernous malformation group is associated with KRIT1, CCM2 or PDCD10 mutations.

These genes pertain to familial CNS cavernous malformations, not all skin hemangiomas.

Vascular lesion reasoning exercise

Illustrative scenario: An infant has an irregular red-blue facial skin lesion that changes over time.

Question

What is the first useful classification question?

Reasoned interpretation

Determine whether this represents a proliferative vascular tumor or a nonproliferative malformation.

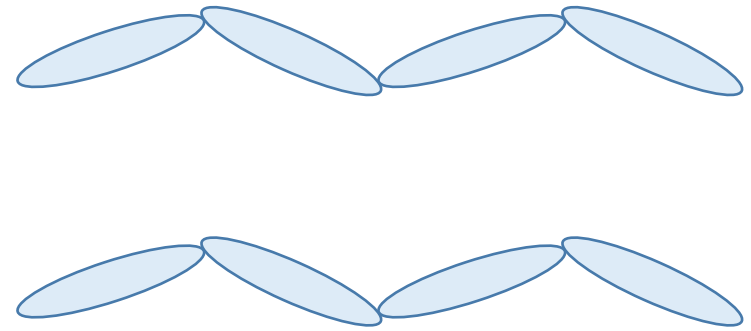
Site and natural history matter; Do not diagnose subtype from color alone.

Fibrous tumors: A broad mesenchymal spectrum

- Fibrous tumors in infants and children are thought to arise from fibroblasts or myofibroblasts.
- The spectrum includes sparsely cellular fibromatosis and highly cellular infantile fibrosarcoma.
- These entities should not be presumed biologically identical because both contain spindle cells.

Fibromatosis: Sparse spindle-cell proliferation

- Fibromatosis is described as a relatively sparsely cellular spindle-cell proliferation.
- Spindle-cell morphology reflects the broad fibroblastic/myofibroblastic category.
- A generic spindle-cell schematic does not establish a tissue diagnosis.



Schematic spindle-cell proliferation

Fibromatosis versus infantile fibrosarcoma

Fibromatosis	Infantile fibrosarcoma
Relatively sparse spindle-cell proliferation.	More cellular lesion; histology can resemble adult fibrosarcoma.
Represents one part of the childhood fibrous-lesion spectrum.	Has its own characteristic molecular and clinical behavior.
Diagnosis requires lesion-specific evaluation.	Its favorable prognosis compared with the adult analogy is noteworthy.

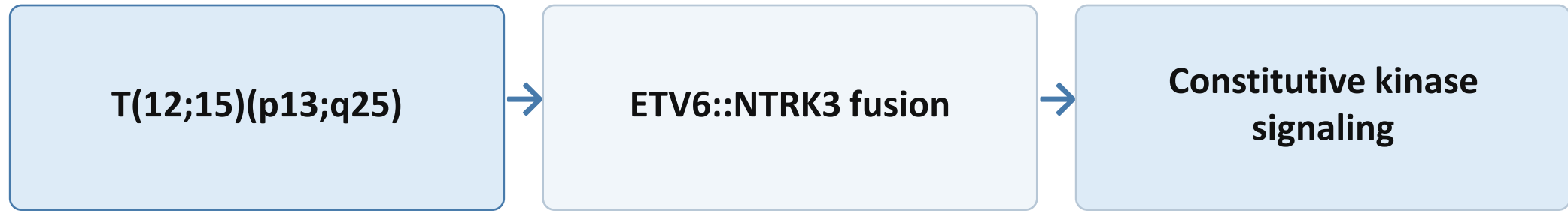
Infantile fibrosarcoma is NOT being reclassified as a benign tumor.

Histologic resemblance does not predict outcome

- Infantile fibrosarcoma may look similar to adult fibrosarcoma under the microscope.
- Despite the similarity, infantile fibrosarcoma generally has an excellent prognosis.
- Age-specific biological context matters when interpreting aggressive-appearing morphology.

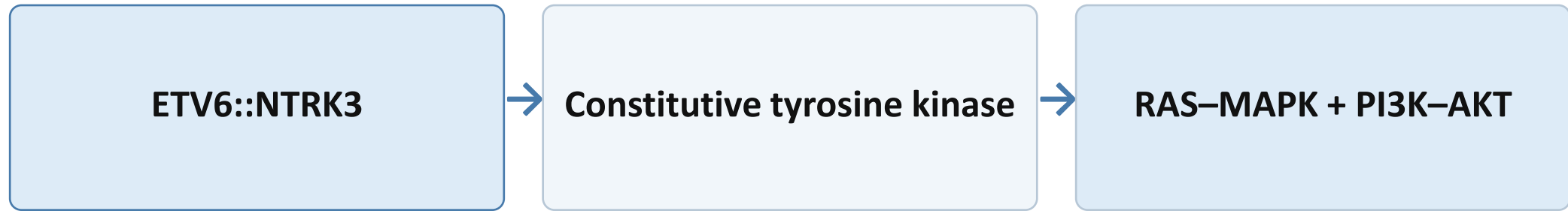
Infantile fibrosarcoma is included as an important differential boundary, not as a benign neoplasm.

The ETV6::NTRK3 fusion mechanism



- ETV6 encodes a transcription factor; NTRK3 encodes the TRKC kinase.
- Fusion protein activates oncogenic signaling pathways.

Fusion-driven signaling in infantile fibrosarcoma



- These cascades provide a mechanistic link to proliferative signaling.
- The diagram summarizes the textbook mechanism, not every molecular interaction.

A diagnostic and therapeutic molecular example

- ETV6::NTRK3 is a characteristic and diagnostically useful fusion in infantile fibrosarcoma.
- The fusion helps separate this entity from morphologically overlapping soft-tissue tumors.
- Selective NTRK inhibitors can produce major antitumor responses in fusion-positive unresectable cases.

Therapeutic statement is source-derived and is not a treatment guideline.

Fibrous lesion interpretation

Illustrative scenario: A young child has a highly cellular spindle-cell soft tissue tumor.

Question

Does adult-type histologic resemblance establish a poor prognosis?

Reasoned interpretation

No. Consider infantile fibrosarcoma and the diagnostic role of ETV6::NTRK3.

Infantile fibrosarcoma is a biologically separate tumor rather than a benign lesion.

Teratomas contain differentiated tissue types

- Teratomas are germ cell neoplasms that may contain tissues from ectodermal, mesodermal and/or endodermal origins.
- The constituent tissues can be mature or immature.
- Biological interpretation depends partly on tissue maturity and other tumor components.

Ectoderm

Mesoderm

Endoderm

Conceptual tissue origins in a teratoma

Teratoma maturity and biological classification

Mature

Well-differentiated, often cystic; Generally benign in this pediatric context.

Immature

Contains immature tissues and has variable/indeterminate potential.

Malignant

May include another malignant germ cell component, such as yolk sac tumor.

Avoid calling all teratomas benign.

Mature teratoma: Defining pathology

- Mature teratomas are well-differentiated lesions.
- They may be cystic.
- Different mature tissue types are arranged in a disordered mixture rather than normal organ architecture.

Immature teratoma: What increases concern

- Immature teratomas contain incompletely differentiated tissue elements.
- Immature neuroepithelium is a particularly important component.
- The extent of immature tissue relates to malignant potential in the chapter's account.

Mature, immature and overtly malignant teratoma

Category	Histologic clue	Biological interpretation
Mature	Well-differentiated tissues; often cystic.	Usually benign.
Immature	Immature elements, often neuroepithelial.	Potential correlates with immaturity.
Malignant	Malignant germ cell component may coexist.	Unequivocally malignant.

Two age-related occurrence peaks

- One incidence peak at approximately 2 years of age.
- A second peak occurs in late adolescence or early adulthood.
- The early peak represents congenital neoplasms; Later lesions may also originate prenatally but grow more slowly.

Sacrococcygeal teratomas: Epidemiologic context

$\geq 40\%$

Of childhood teratomas arise at the sacrococcygeal site.

1 in 20,000–40,000

Live births: Reported frequency of sacrococcygeal teratoma.

4:1

Female-to-male predominance.

These are textbook-reported figures, not independently updated surveillance estimates.

Sacrococcygeal site and congenital anomalies

- The sacrococcygeal region is the most frequent location of childhood teratomas.
- About 10% are associated with congenital anomalies, particularly hindgut, cloacal or midline defects.
- The associated defects are not considered simply the result of local tumor pressure.

Sacrococcygeal teratoma histologic categories

~75%

Reported as mature
teratomas.

~12%

Reported as unequivocally
malignant.

Remainder

Reported as immature
teratomas.

Approximate textbook estimates for sacrococcygeal lesions; Site- and era-specific.

Age and behavior in sacrococcygeal tumors

- Most benign sacrococcygeal teratomas occur in younger infants, particularly before 4 months.
- Children with malignant lesions tend to be somewhat older.
- Age adds context but cannot replace histopathologic classification.

Other pediatric teratoma locations

Gonadal

Testis and ovary.

Central trunk

Mediastinum and retroperitoneum.

Other midline

Head and neck regions.

The source refers to organ-specific chapters for detailed pathology.

Teratoma classification exercise

Illustrative scenario: A sacrococcygeal mass contains abundant mature epithelial and mesenchymal tissue with focal immature neuroepithelium.

Question

Should this be called a purely mature lesion?

Reasoned interpretation

No. Immature neuroepithelium requires consideration of an immature teratoma and appropriate risk assessment.

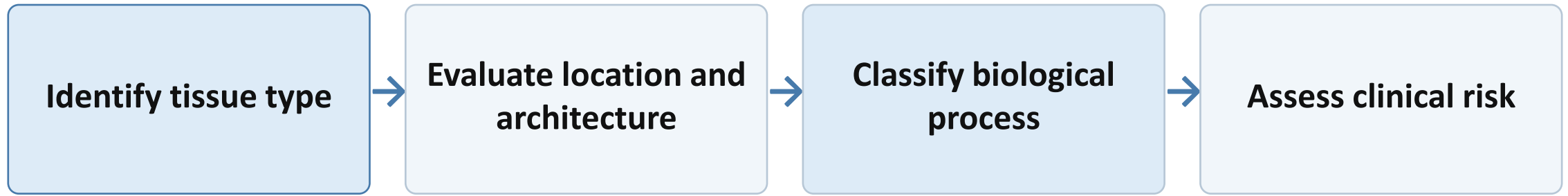
No grading thresholds are inferred beyond Key Pathologic Findings in this chapter.

Integrated comparison of pediatric mass-forming lesions

Lesion group	Key identifying feature	Principal caution
Heterotopia	Normal tissue in an ectopic location.	Can mimic a neoplasm.
Hamartoma	Disordered local overgrowth of native elements.	Clonality may blur taxonomy.
Vascular lesions	Tumor versus malformation biology.	Terminology and evolution vary.
Fibrous lesions	Spindle cells, variable cellularity.	Infantile fibrosarcoma is not simply benign.
Teratoma	Mature/immature germ-layer tissues.	Maturity and malignant components matter.

Categories are conceptually different and not mutually exclusive in all settings.

A practical classification sequence



- If native tissue is ectopic, consider heterotopia.
- If native tissue forms a disordered overgrowth, consider hamartoma.
- For vascular or germ-cell lesions, apply lesion-specific classification.

Integrated case: The benign-appearing mass

Illustrative scenario: A childhood mass has mature, bland cells but is compressing an adjacent structure.

Question

What conclusion would be unsafe?

Reasoned interpretation

That benign histology guarantees clinical insignificance. Location and mass effect can be decisive.

Management discussion is intentionally general, not a patient-specific recommendation.

Diagnostic checkpoints for teaching and practice

- Keep lesion identity, tissue maturity and anatomical location as separate observations.
- Do not equate “hemangioma” with every vascular malformation or “teratoma” with benignity.
- Do not borrow adult prognostic expectations for infantile fibrosarcoma.
- Use source-specific definitions and specialist evaluation for individual lesions.

Core synthesis

- Heterotopia: Normal tissue, abnormal site; Hamartoma: Native tissue, disordered excess.
- Pediatric benign/tumor-like lesions often reflect mesenchymal or developmental processes.
- Vascular lesions require biologic subclassification; Fibrous lesions require age-appropriate interpretation.
- Teratoma maturity and coexisting malignant elements guide biological assessment.

Histology and clinical consequences are distinct axes of evaluation.

Primary reference and verification boundaries

- Robbins, Cotran & Kumar: Pathologic Basis of Disease, 11th ed. (2026).
- Chapter 10: Diseases of Infancy and Childhood, “Tumors and Tumor-Like Lesions,” pp. 432–434.
- Content synthesized from the supplied Markdown conversion and directly adjacent subsection text.
- Textbook figures and external histology were not reproduced; diagrams are original conceptual schematics.