

NEET SS

ENDOCRINE SURGERY
SURGICAL ONCOLOGY

EDITION 3.0

INDEX

S.No.	Topic	Page No.
II.	**Endocrine Surgery**	
II.1	Embryology, Anatomy And Physiology Of Thyroid	1
II.2	Thyroid Investigations And Thyroiditis	6
II.3	Diagnostic Systems And Malignancies Of The Thyroid Gland	10
II.4	Malignant Thyroid Swelling	18
II.5	Management Of Thyroid Malignancies And Their Complications	23
II.6	Neck Nodes In Thyroid Malignancy	30
II.7	Goiter & Evaluation Of Thyroid Nodules	37
II.8	Thyrotoxicosis	42
II.9	Sabiston 22nd Updates - Embryology, Anatomy And Physiology Of Thyroid	47
II.10	Parathyroid Embryology And Physiology	51
II.11	Parathyroid Localisation Surgery Recurrence	54
II.12	Parathyroid PHPT Familial	62
II.13	Anatomy And Physiology Of Parathyroid	65
II.14	Parathyroid Disorders And Investigations	70
II.15	Parathyroid Hereditary Syndromes	76
II.16	Hypercalcemia And Hyperparathyroidism	80
II.17	Primary Hyperparathyroidism	82
II.18	Secondary Hyperparathyroidism	91
II.19	Adrenal Gland Part 1	95
II.20	Adrenal Gland Part 2	103
II.21	Adrenal Gland Part 3	111
II.22	Adrenal Gland Part 4	117
II.23	Multiple Endocrine Neoplasia	124
II.24	Pancreatic Neuroendocrine Tumours Part 1	130
II.25	Pancreatic Neuroendocrine Tumours Part 2	133

12. Surgical Oncology

12.1 Cancer Biology Part 1 138

12.2 Cancer Biology Part 2 145

12.3 General Oncology 160

12.4 Low & High Grade Appendiceal Mucinous Neoplasm 164

12.5 Peritoneal Surface Malignancy & HIPEC 168

12.6 Approach To Breast Disorders Andi, Triple Assessment, And Diagnostic Modalities 176

12.7 Mammography And BIRADS 178

12.8 Sabiston 22nd Edition Updates - Breast Cancer - Imaging, Surgery & Systemic Therapy 185

12.9 Risk Factors, Prevention And Evidence Based Trials 190

12.10 Breast Disorders 193

12.11 Benign Breast Disorders 201

12.12 Breast Cancer Treatment 205

12.13 DCIS Management 209

12.14 Special Treatments For Ca Breast 214

12.15 Head And Neck Part 1 222

12.16 Head And Neck Part 2 229

12.17 Head And Neck Part 3 238

12.18 Head And Neck Part 4 252

12.19 Head And Neck Part 5 255

12.20 Sabiston 22nd Edition Updates - Head & Neck 270

12.21 Bone Tumours Part 1 276

12.22 Bone Tumors Part 2 279

12.23 Musculoskeletal Disorders 288

12.24 Soft Tissue And Skeletal Sarcoma 295

12.25 ILP and ILI In Melanoma 301

12.26 Skin - Anatomy & Benign Disorders 303

12.27 Melanoma 310

12.28 Non Melanoma Skin Cancer (SCC and BCC) 314

12.29 Sabiston 22nd Edition Updates - Melanoma 321

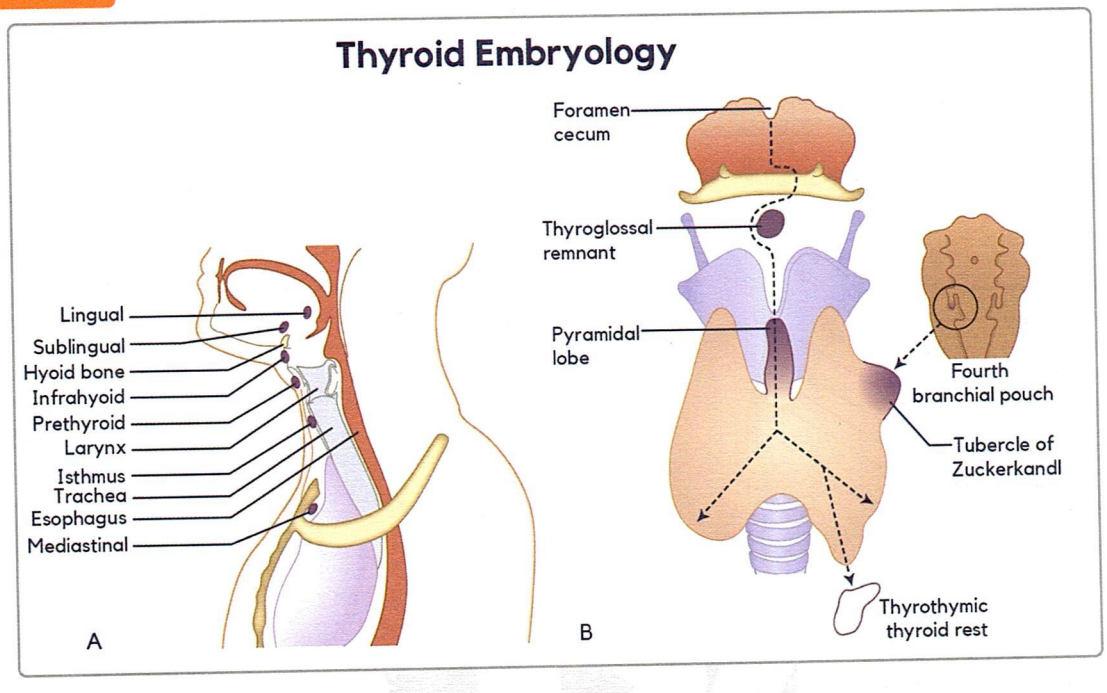
12.30 Sabiston 22nd Edition Updates - Non Melanoma 328

EMBRYOLOGY, ANATOMY AND PHYSIOLOGY OF THYROID



EMBRYOLOGY

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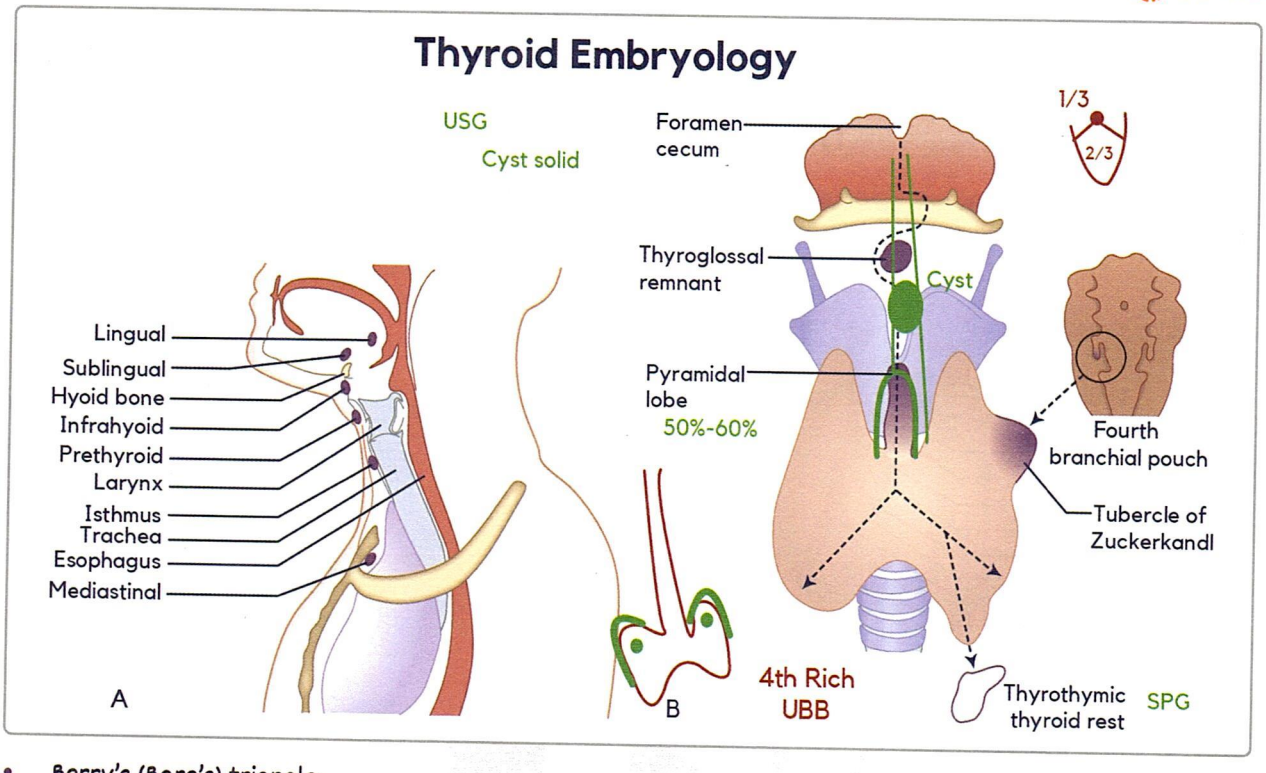


- Median thyroid bud:
  - Arises from endoderm between the first and second pharyngeal pouches.
  - Forms the thyroglossal duct; its remnants form thyroglossal cysts, usually perihyoid.
- Ultimobranchial body (4th pouch):
  - Gives rise to parafollicular cells of neuroectodermal origin.
- Third pharyngeal pouch:
  - Forms thymus and inferior parathyroid glands.
- Fourth pharyngeal pouch:
  - Forms superior parathyroids and ultimobranchial body.
- Ectopic thyroid tissue:
  - May occur anywhere along the thyrothymic tract; incidence about 30–50%.
- Lateral "aberrant thyroid":
  - Term is a misnomer; a lateral mass usually represents a metastatic lymph node from papillary thyroid carcinoma (PTC).
- Thyroglossal cysts:
  - 80% at the hyoid level, often slightly leftsided.
  - 20% contain thyroid tissue; any differentiated thyroid cancer (papillary, follicular, Hürthle cell) or anaplastic carcinoma can arise.
  - Medullary thyroid carcinoma (MTC) does not arise (no Ccells from ultimobranchial body).
  - Squamous cell carcinoma reported rarely.
- Pyramidal lobe:
  - Distal remnant of thyroglossal tract.
  - Present in about 30–50% of patients (as per Sabiston)
- Preoperative check:
  - Confirm normally located thyroid tissue by neck ultrasound (or radioiodine scan if needed) before surgery, as cyst may rarely be the only thyroid tissue.

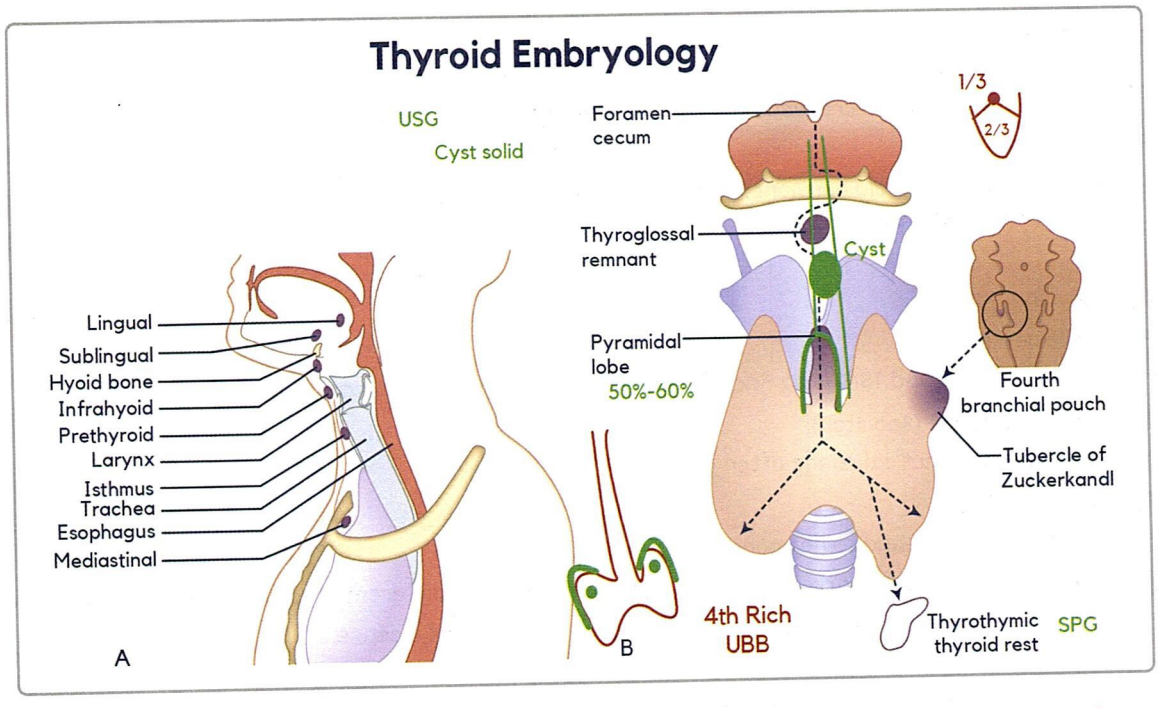
- Sistrunk procedure (modified):
  - Excision of cyst, tract, and central portion of hyoid bone.
  - Tract is removed up to the mylohyoid/constrictor muscles.
  - Routine lingual coring up to foramen cecum is not usually required (lingual extension is rare).

ANATOMY

00:05:59



- Berry's (Bare's) triangle:
  - Inferomedial boundary: Recurrent laryngeal nerve (RLN).
  - Posterior/lateral boundary: Common carotid artery.
  - Superior boundary: Inferior thyroid artery (ITA).
- Recurrent laryngeal nerve:
  - Nerve of the 6th pharyngeal arch.
  - Nonrecurrent RLN:
    - Occurs almost always on the right side.
    - Exam incidence: 0.5–1% (mark 0.5% if given).
  - Anterior branch variant:
    - In 20–30% of patients an anterior motor branch enters near the cricothyroid joint; important during surgery.
- External branch of superior laryngeal nerve (EBSLN):
  - At risk during ligation of superior pole vessels.
  - Type 2a (nerve crossing within 1 cm of upper pole vessels) is most injuryprone and examfavoured(~20%).
  - Supplies cricothyroid muscle → controls pitch and voice projection.
- Thyroid capsule and pseudolobules:
  - Fibrous capsule sends septa into gland forming pseudolobules.
  - Posterior thickening of pretracheal fascia/capsule forms Berry's ligament, a key RLN injury zone.
- Blood Supply and Parathyroid Perfusion
  - Inferior thyroid artery (ITA):
    - Supplies parathyroids in about 80% of cases (both superior and inferior).
  - Superior thyroid artery:
    - Supplies parathyroids in about 20% of cases.
    - May be the sole arterial supply in some patients.



00:10:24

Lymph Nodes and Metastasis

- Most common involved nodes in thyroid carcinoma:
  - Central compartment (Level 6) is most common.
  - Lateral neck: Levels 2A, 3, and 4 are typical.
- Skip metastasis:
  - Direct spread from thyroid to lateral nodes without Level 6 involvement in about 15%.
- Level 6 (central compartment) boundaries:
  - Superior: Hyoid bone.
  - Lateral: Carotid sheaths.
  - Inferior: Jugular (suprasternal) notch.
- Level 7 (superior mediastinal):
  - From jugular notch down to brachiocephalic (innominate) vein.

00:15:15

Physiology — Synthesis and Regulation

- Steps of thyroid hormone synthesis:
  - Iodide trapping.
  - Oxidation of iodide to iodine.
  - Iodination of tyrosine (forming MIT and DIT).
  - Coupling of MIT/DIT to form T3 and T4.
- Thyroid peroxidase (TPO):
  - Acts in oxidation and coupling steps.
- Inhibitors:
  - Iodide trapping: inhibited by perchlorate, thiocyanate.
  - Oxidation/organification: inhibited by carbimazole and PTU (propylthiouracil).
  - Coupling/peripheral T4→T3: PTU preferentially inhibits.
- Wolff–Chaikoff effect:
  - Large iodide load → transient inhibition of organification → antithyroid, goitrogenic effect with reduced gland vascularity.
- Distribution and activity:
  - Most hormone proteinbound (prealbumin, TBG).
  - Free T4 ~0.03% of total.
  - Free T3 is more biologically active.

- Deiodinases:
  - Type 2 deiodinase:
    - Converts T4→T3; decreased activity in sick euthyroid syndrome.
  - Type 3 deiodinase:
    - Inactivates thyroid hormone; increased activity implicated in some iatrogenic effects (e.g. sorafenibrelated).

Laboratory Testing

00:15:45

- Preferred tests:
  - Free T3, free T4, and TSH using Radio-Immuno Assay or chemiluminescence assays.
- TSH reference range (Sabiston):
  - 0.4–4.1 mIU/L (practical range often 0.5–5).
- Thyroglobulin (Tg):
  - Stored in colloid, bound to hormones.
  - Highly sensitive tumor marker after total thyroidectomy for differentiated thyroid cancer.
  - Stimulated Tg >1–2 ng/mL (mg%) suggests residual or recurrent disease.
  - AntiTg antibodies:
    - Present in about 10–20% (lecture ~15%).
    - Cause falsely low Tg levels by blocking assay binding.
    - Rising antiTg or disappearance after therapy can act as surrogate markers of disease activity.
- Calcitonin:
  - Limited role in normal calcium homeostasis; physiological importance is minimal.
  - Key biochemical marker for medullary thyroid carcinoma (MTC).
  - Any detectable or elevated level warrants MTC workup and guides treatment planning.

Clinical Conditions – Pregnancy and Thyroid

- First trimester transient hyperthyroidism:
  - Due to hCG α-subunit mimicking TSH, stimulating thyroid.
  - Usually self-limiting and managed conservatively.
- Most common thyroid dysfunction in pregnancy:
  - Hypothyroidism (~0.5% of pregnancies).
  - Important due to risk of neurodevelopmental problems in fetus/child.
- Hyperthyroidism/Graves disease:
  - Less common (~0.3%; about half the rate of hypothyroidism).
- Postpartum thyroiditis:
  - Typically selflimiting, resolves in 4–8 weeks.
  - May need temporary levothyroxine.
  - Increases future risk of Hashimoto's thyroiditis by about 10fold.
- Sick Euthyroid Syndrome
  - Seen in severe illness, trauma, sepsis, and postoperative states.
  - Due to reduced type 2 deiodinase activity → less peripheral T3 production.
  - Causes abnormal thyroid function tests without primary thyroid disease.

Imaging

00:27:10

- Ultrasound:
  - Firstline imaging for thyroid gland and nodules.
  - Homogeneous echotexture: normal.
  - Heterogeneous echotexture or multiple nodules suggests thyroiditis or multinodular goitre.

- PET/CT incidental thyroid uptake:
  - Incidence of PETdetected thyroid nodules ≈ 3%.
  - Malignancy risk in PETavid nodules ≈ 20% (some texts quote 30–50%).
- CT/MRI:
  - Incidental thyroid nodules on CT/MRI up to ≈9%.
  - Iodinated contrast may be used when needed (e.g. retrosternal extension, locally advanced disease).
  - After iodinated contrast, delay radioiodine scanning/therapy for 8–12 weeks (minimum 8 weeks).
- Radionuclide scans (I123 or I131):
  - Cold nodules: malignancy risk 15–20%.
  - Hot nodules: malignancy risk about 1–3% (generally <5%).

Thyrotoxicosis and Hypothyroidism Management

00:31:12

- Hypothyroidism treatment:
  - Firstline replacement: levothyroxine (LT4, T4, Lthyroxine).
  - T3 therapy (liothyronine) has no proven longterm advantage over T4 alone.
- Iatrogenic/druginduced dysfunction:
  - Radioiodine (I131) can cause hypothyroidism.
  - Amiodarone and tyrosine kinase inhibitors:
    - Amiodarone, sunitinib: may cause destructive thyroiditis.
    - Sorafenib: associated with increased type 3 deiodinase activity and iatrogenic thyroid dysfunction.

Thyroiditis Types and Management

- Hashimoto's thyroiditis (chronic autoimmune):
  - Marked female predominance (~10:1).
  - AntiTPO antibodies positive in 90–95%.
  - Familial/hereditary tendency in firstdegree relatives.
  - Associated malignancies:
    - Primary thyroid lymphoma is most common.
    - Papillary thyroid carcinoma (PTC) risk is also increased.
- Postpartum thyroiditis:
  - Often self-limiting, resolves in 4–8 weeks.
  - Treat with levothyroxine if symptomatic or significantly hypothyroid.
  - Carries high future risk of Hashimoto's (10-fold).
- Suppurative (acute) thyroiditis:
  - Often due to piriform sinus fistula communicating with thyroid.
  - Common organisms: Staphylococcus aureus, streptococci.
  - Management: antibiotics plus aspiration or drainage of abscess if required.

THYROID INVESTIGATIONS AND THYROIDITIS

TRIPLE ASSESSMENT FOR EVALUATING AND MANAGING THYROID CONDITIONS:

- Clinical Assessment
- Radiological Assessment
- Pathological Assessment

This ensures that clinicians can distinguish between benign conditions and malignancies of thyroid

Q. REGARDING THYROID SCAN – TRUE IS

a. I123 has a half-life of 8 hours and I131 has a half-life of 13 days
b. I131 – scan used to identify metastasis after surgical lobectomy
c. 75% of warm swellings are benign
d. Tc99m Isotope scan is indicated in a discrete swelling with toxicity
ANSWER: d.

- Thyroid scans indicated in the combination of
  - Discrete swelling (nodule) with toxicity
  - Post-operative scan to identify metastases after a TOTAL THYROIDECTOMY (NOT LOBECTOMY) Why? Any metastases in the body cannot be made out on scan in presence of a functioning thyroid tissue as the entire dose given will be taken up by the functioning tissue

Ref: Sabiston 21st edition Pg.882/ Bailey 27th edition pg. 804/ Schwartz 11th edition 1633-37

RADIOACTIVE IODINE (ISOTOPE) SCANS

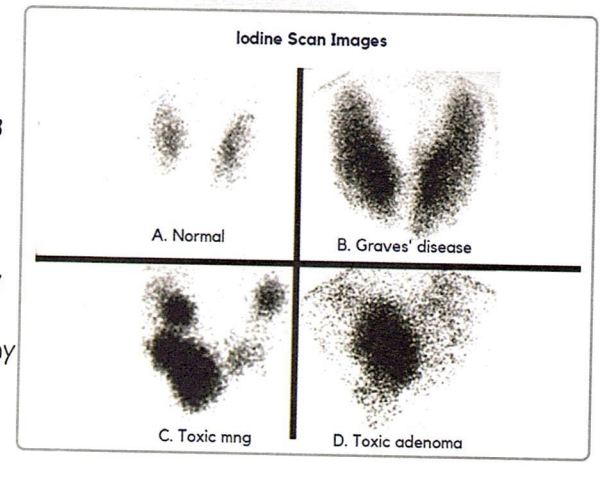
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Indications

- Evaluation of a discrete nodule with toxicity
- Post-operative monitoring after a total thyroidectomy in DTC – to identify metastases

Agents and Half-lives:

- Iodine-123:
  - Preferred for diagnosis due to its short half-life of 13 hours.
  - Prevents stunning of thyroid
- Iodine-131:
  - Typically used for therapy because of its longer 8-day half-life.
  - Used to identify metastases after Total thyroidectomy
- Technetium-99m: Can also be used for thyroid scanning.
- Sestamibi: Used mainly for Parathyroid. May also show uptake by thyroid.

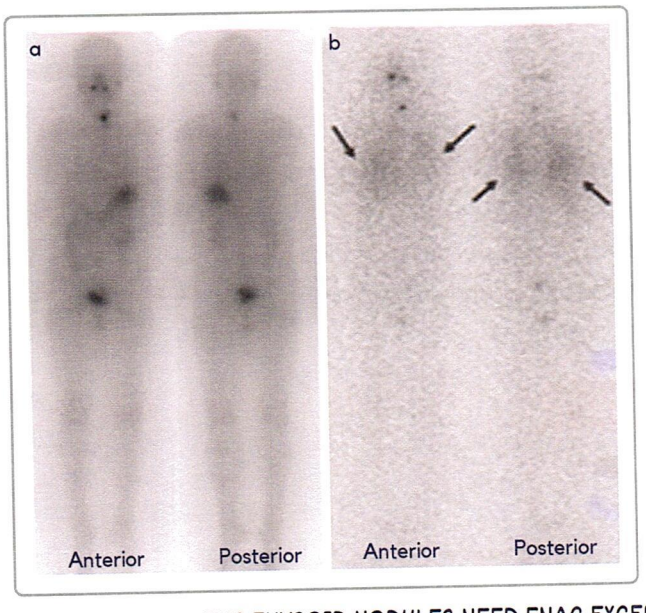


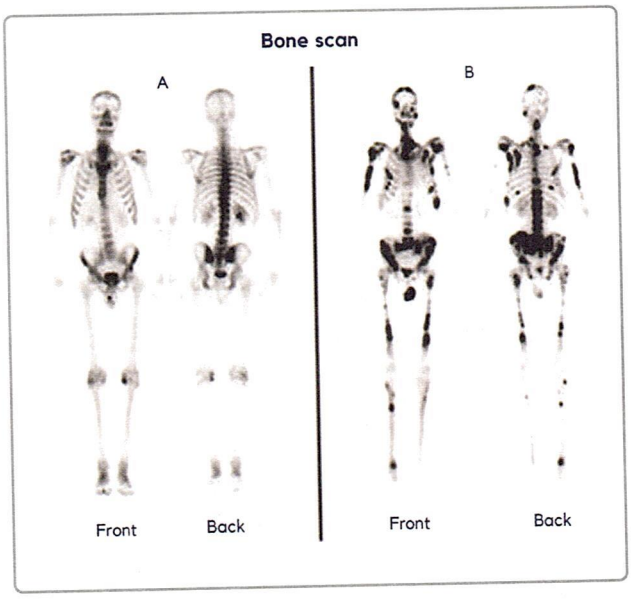
Iodine Scan Images:

- Diffuse uptake on both sides of gland – GRAVES DISEASE
- Size does not correlate with activity in iodine scans
- Multiple areas of uptake – TOXIC MNG – most of the nodules are cold and the internodular tissue will be active (hot)
- Malignancy Risk:
  - Approximately 95% of "hot" (active) nodules are benign
  - "Cold" nodules -> higher malignancy risk ~ 20%.

Whole-Body Scans:

- Post-ablation, typically **2 to 3 days** after the procedure, to identify metastasis in areas like the lungs or bones.
- Unlike bone scans, functional iodine scans do **not** show a clear skeletal outline.





Q. ALL THE FOLLOWING THYROID NODULES NEED FNAC EXCEPT:

a. 0.9 cm nodule with irregular borders with microcalcification and increased vascularity
b. 2 cm isoechoic solid nodule without high-risk features
c. 2 cm spongiform nodule without high-risk features
d. 5 cm cystic nodule with 1 cm solid mural nodule

ANSWER: a.

Ref: Sabiston 21st edition Pg. 894/ Schwartz 11th ed. Pg 1643-44

FNAC AND RISK STRATIFICATION

00:19:14

Fine Needle Aspiration Cytology (FNAC) is guided by size and USG features (Red flags include hypoechoic, solid, microcalcifications, irregular margins, increased vascularity and a "taller-than-wide" shape, evidence of extra-thyroid extension, presence of nodes).

According to **ACR-TIRADS SCORING SYSTEM**; Indications to do FNAC

- ≥7: TIRADS 5
- ≥4: TIRADS 4

American Thyroid Association Sonographic Patterns and Estimated Risk of Malignancy for Thyroid Nodules

Sonographic pattern	SONOGRAPHIC FEATURES	Estimated risk of malignancy	CONSIDER BIOPSY
High suspicion	Solid hypoechoic nodule or solid hypoechoic component of a partially cystic nodule with one or more of the following features: irregular margins (infiltrative, microlobulated), microcalcifications, taller-than-wide shape, rim calcifications with small extrusive soft-tissue component, evidence of extrathyroidal extension	>70-90	≥1 cm
Intermediate suspicion	Hypoechoic solid nodule with smooth margins without microcalcifications, extrathyroidal extension, or taller-than-wide shape	10-20	≥1 cm
Low suspicion	Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid areas, without microcalcification, irregular margin or extrathyroidal extension, or taller-than-wide shape.	5-10	≥1.5 cm
Very low suspicion	Spongiform or partially cystic nodules without any of the sonographic features described in low, intermediate, or high suspicion patterns	<3	≥2 cm
Benign	Purely cystic nodules (no solid component)	<1	No biopsy!

- **Solid hypoechoic nodules:** Size cut-off ≥1.0 cm.
- **Solid iso- or hyperechoic nodules:** Size cut-off ≥1.5 cm.
- **Spongiform nodules:** Size cut-off ≥2.0 cm.
- **Purely cystic nodules:** Generally, no biopsy is needed as the risk of malignancy is <1%.

Size of the nodule does not matter in a patient with history of radiation exposure or family history

Q. FIRST INVESTIGATION IN THE EVALUATION OF A THYROID NODULE IS

a. FNAC
b. USG
c. Serum TSH
d. Iodine Scan

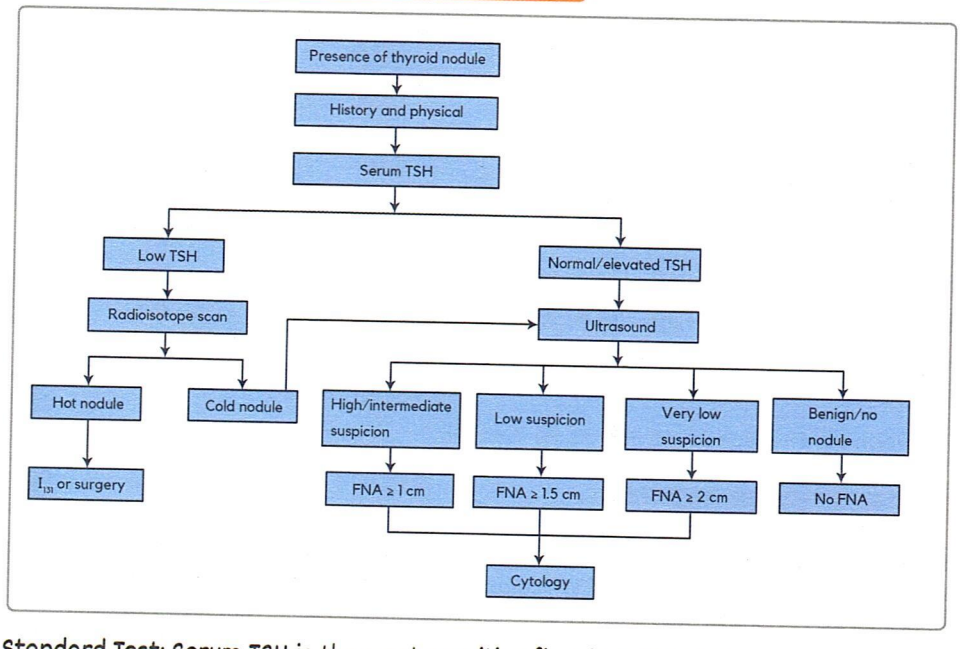
ANSWER: c

- Serum TSH – if elevated/normal then USG is done – if suppressed then Iodine scan is indicated
- Neck USG is the preferred modality for routine radiographic evaluation of thyroid
- CT and MRI are useful in advanced cancers and substernal goitres
- Iodine contrast is cleared by 4-8 weeks after which Iodine scan is done (Typically 8 weeks)
- PET positive thyroid nodules – 35% risk of malignancy (Sabiston 22nd ed: 20%)

Ref: Sabiston 21st edition Pg. 892 (Fig. 37.14)/ Schwartz 11th Ed. Pg 1633

Initial Evaluation and Diagnostic Backbones

00:29:11



- The Gold Standard Test: Serum TSH is the most sensitive first investigation.
- CT and MRI are reserved for:
  - Locally advanced DTC
  - Large benign glands
  - Cases with substernal extension

Q. FALSE ABOUT HASHIMOTO'S THYRODITIS

a. M/C cause of Hypothyroidism in iodine deplete areas
b. Highest sensitivity is for TPOAb for detection of Hashimoto's
c. Hashimoto's thyroiditis is associated with PTC
d. FNAC shows cellular picture follicular cells and Hurthle cells

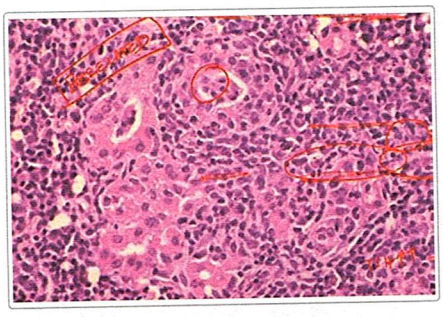
ANSWER: a

- M/C cause of Hypothyroidism in IODINE REPLETE areas is Autoimmune Thyroiditis
- 5% patients have Thyrotoxicosis (Hashitoxicosis)
- FNAC shows cellular smear with follicular cells, Hurthle cells
- POST-PARTUM THYROIDITIS – Painless; 10% of women develop similar picture in 2-12 months → Resolution in 3-4 months → High level of TPOAb → 10-fold risk of Hashimoto's thyroiditis in future

Ref: Sabiston 21st edition Pg. 884-85/ Schwartz 11th Ed. Pg 1639-40

Clinical Features of Thyroiditis

00:34:45



1. **Hashimoto's Thyroiditis (Autoimmune Thyroiditis):**
   - Autoimmune condition
   - M/C cause of hypothyroidism in **Iodine-replete** areas
   - Characterized by a **firm, rubbery, "bosselated" appearance**
   - Pathology: **Lymphocytic infiltration** and **Ashkenazi (Hürthle) cells.**
   - Long-term risk of **B-cell lymphoma** >> PTC
   - Management: **Medical** mostly -> Beta-blockers during period of Hashitoxicosis initially f/b TSH testing – once TSH starts to rise; plan for **replacement** with Thyronorm. Plan surgery if large goitre, compressive symptoms or suspicious nodules

Q. REGARDING THYROIDITIS – WHICH IS FALSE:

a. **Reidel's thyroiditis is associated with mediastinal fibrosis**
b. **Hashimoto's thyroiditis can lead to B cell lymphomas of thyroid**
c. **De Quervain's thyroiditis shows high uptake on I131 scan**
d. **Reidel's thyroiditis always needs a biopsy**

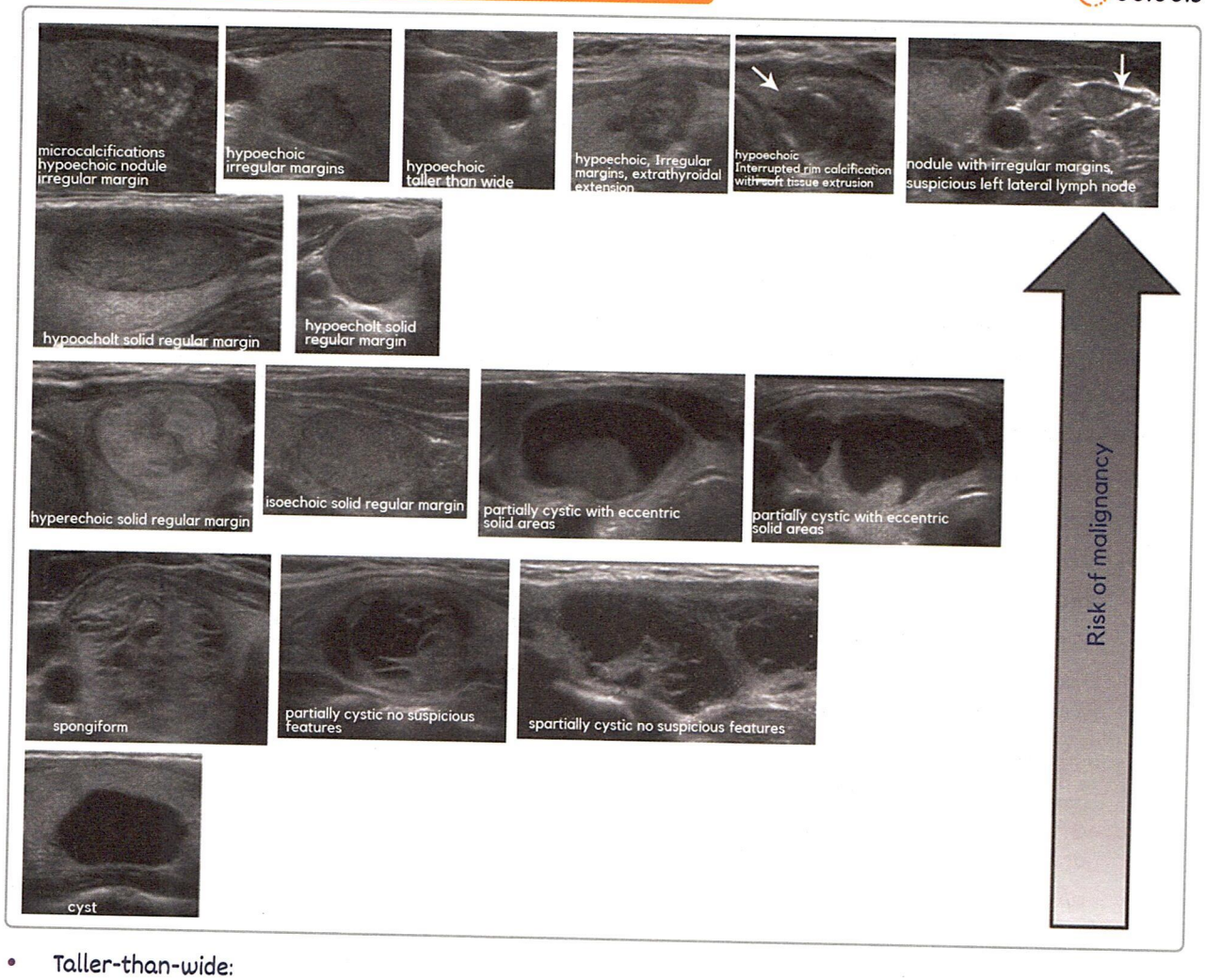
ANSWER: C

Ref: Sabiston 21st edition Pg. 885 (Box 37.2) Bailey 27th edition Pg. 821-22/ Scwartz 11th Ed. Pg 1639-40

2. **De Quervain's (Subacute) Granulomatous Thyroiditis:**
   - Self-limiting inflammatory condition
   - Females (2:1)
   - a/w HLA B35 haplotype
   - Presents with a **painful swelling, raised ESR, and giant cell granulomas** on FNAC
   - Hallmark feature: shows **low uptake** on a radioactive iodine scan
3. **Riedel's Thyroiditis (chronic/invasive fibrous thyroiditis):**
   - Rare, painful, "woody-hard," invasive fibrous condition
   - a/w **IgG4-related systemic disease**
   - Often requires an **isthmusectomy** (surgical biopsy) to relieve tracheal compression and rule out anaplastic carcinoma/ lymphoma
   - a/w mediastinal / retroperitoneal fibrosis
   - Management:
     - Steroids/ Tamoxifen are used along with Thyroxine for hypothyroidism
     - M/C surgery done: Wedge resection of isthmus → No risk of malignancy
     - Mycophenolate mofetil/ rituximab used recently with great effect

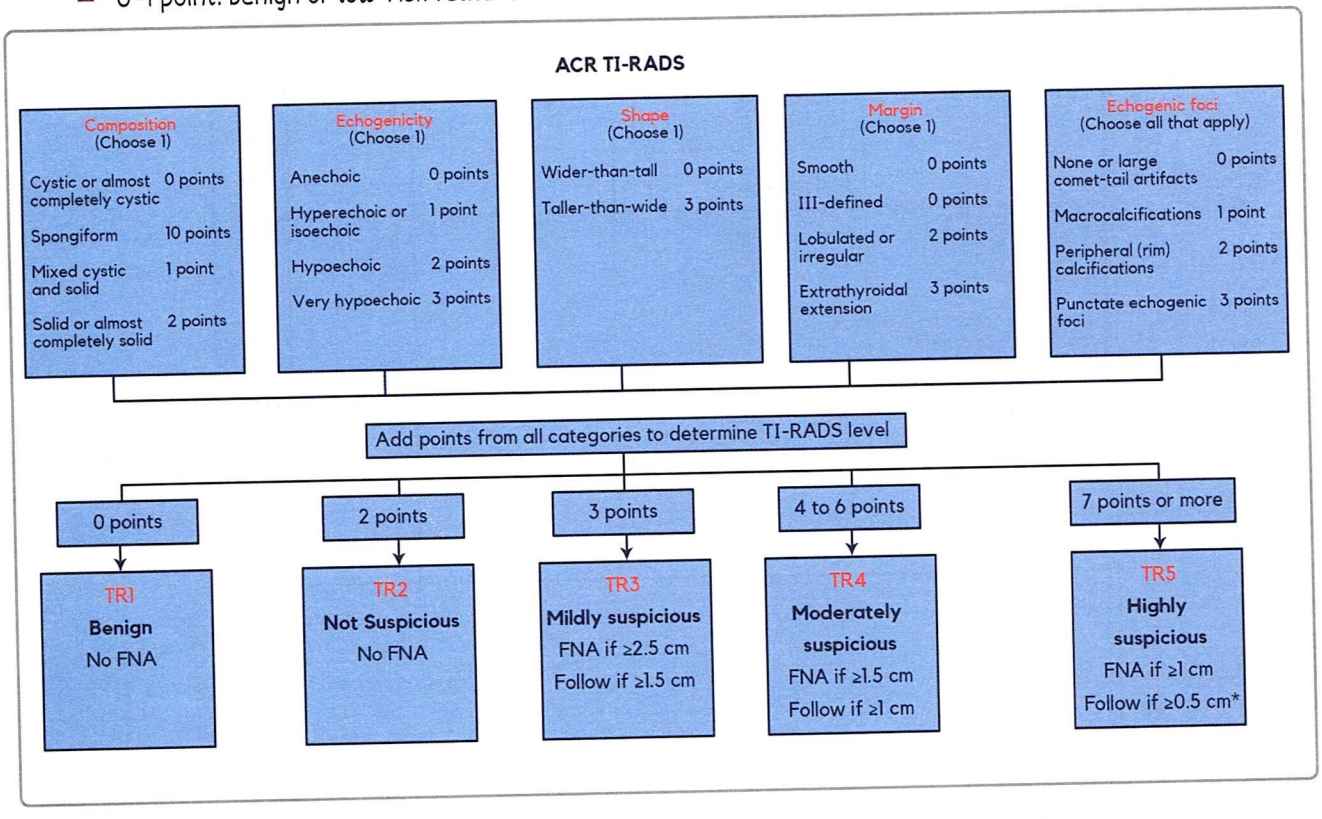
Ultrasound Features And Risk Stratification

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- Taller-than-wide:
  - Measure AP/transverse ratio; AP ≥ transverse = taller-than-wide.
  - Taller-than-wide is highly suspicious for PTC.
- Echogenicity:
  - Hypoechoic solid nodule = intermediate or high risk.
  - Very hypoechoic: echogenicity lower than strap muscles → high-risk (3 points in TI-RADS).
  - Isoechoic / hyperechoic solid nodules = lower risk.
- Benign pattern nodules:
  - Pure cyst: <1% malignancy → no FNAC.
  - Spongiform nodule: <3% malignancy → benign pattern.
- Solid and partly cystic nodules:
  - Solid nodule or eccentric solid component in a cyst increases malignancy risk.
  - Iso- or hyperechoic solid nodules: FNAC usually if size thresholds met.
- High-risk ultrasound features:
  - Punctate (micro) calcifications.
  - Extrathyroidal soft-tissue extension.
  - Taller-than-wide shape.
  - Very hypoechoic solid nodule.

  - Irregular / lobulated / crenelated margins.
  - Suspicious lymph nodes.
- Intermediate-risk features:
  - Rim (peripheral) calcification.
  - Irregular margins without other very high-risk signs.
  - Solid hypoechoic nodule (even with regular margins) scores high enough to trigger FNAC.
- ACR TI-RADS scoring points:
  - 3-point features: very hypoechoic, taller-than-wide, extrathyroidal extension, punctate microcalcifications.
  - 2-point features: rim calcification, irregular / lobulated margins, solid composition, hypoechoic (not very hypoechoic).
  - 0–1 point: benign or low-risk features.



- TI-RADS categories and FNAC thresholds:
  - TR3: FNAC if ≥2.5 cm.
  - TR4: FNAC if ≥1.5 cm.
  - TR5 / highly suspicious (≥7 points): FNAC if ≥1.0 cm.
- ATA guideline cutoff:
  - Solid hypoechoic suspicious nodule: FNAC from 1.0 cm.
- Key correlation:
  - Psammoma bodies on histology correspond to microcalcifications on US and suggest PTC.