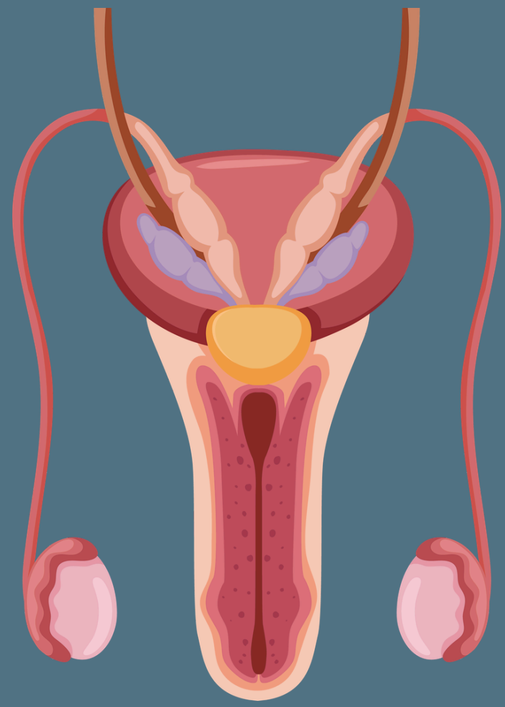
ANATOMY & PHYSIOLOGY OF ERECTION AND EJACULATION

Presented by:
Heba Abu Nawas
Shaimaa Al Mustafa
Leen Al Tarawneh

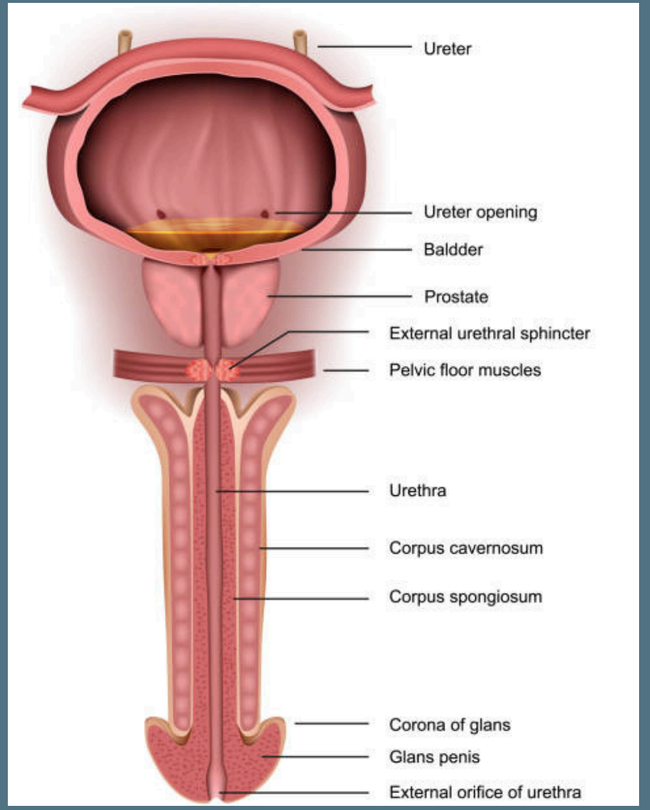


Anatomy

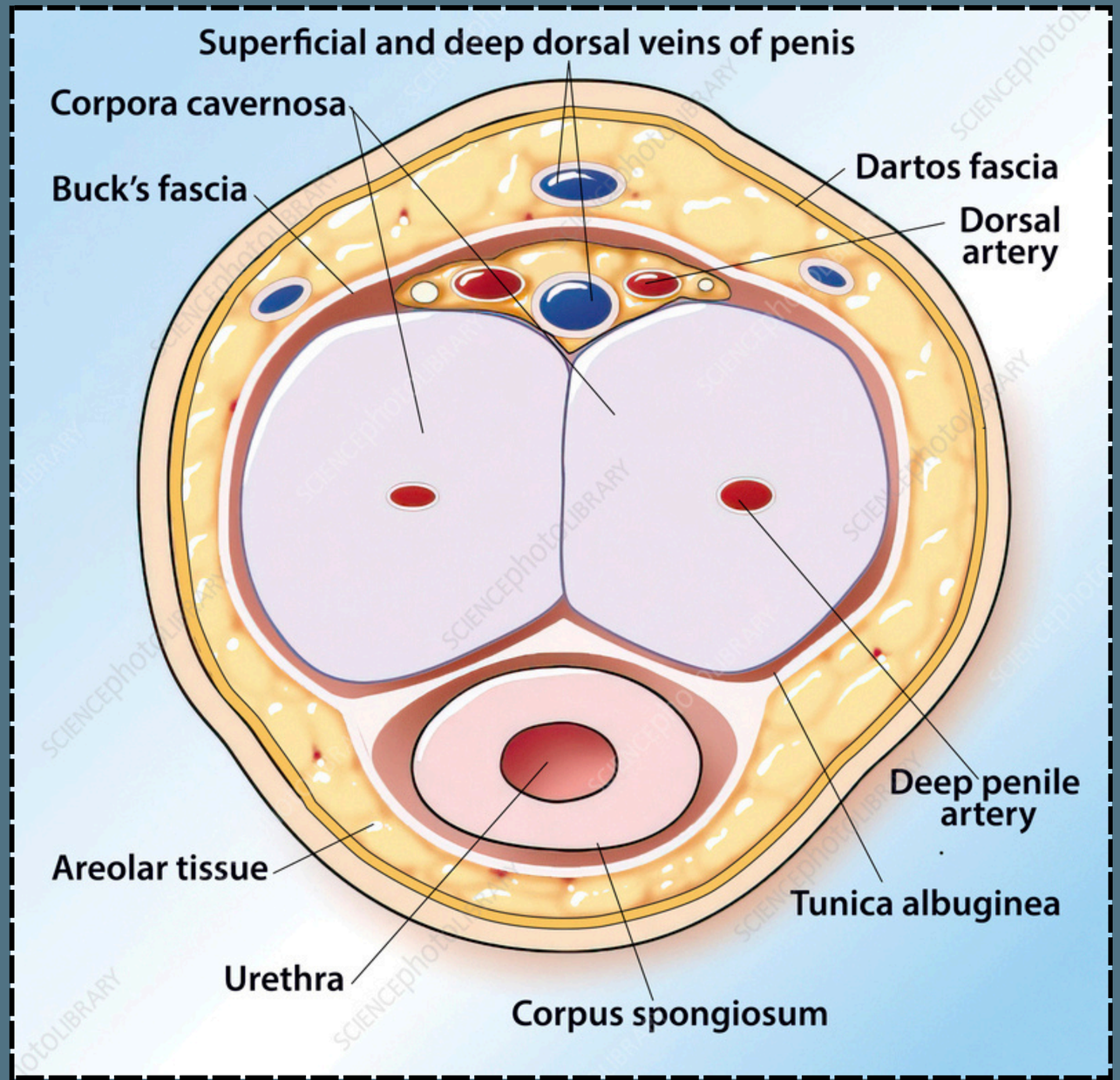
The penile shaft is composed of 3 erectile columns ,the 2 corpora cavernosa and the corpus spongiosum, The single corpus spongiosum lies in the ventral groove between the 2 corpora cavernosa.

The urethra passes through the corpus spongiosum.

The erectile tissue within the corpora contains arteries, nerves, muscle fibers, and venous sinuses

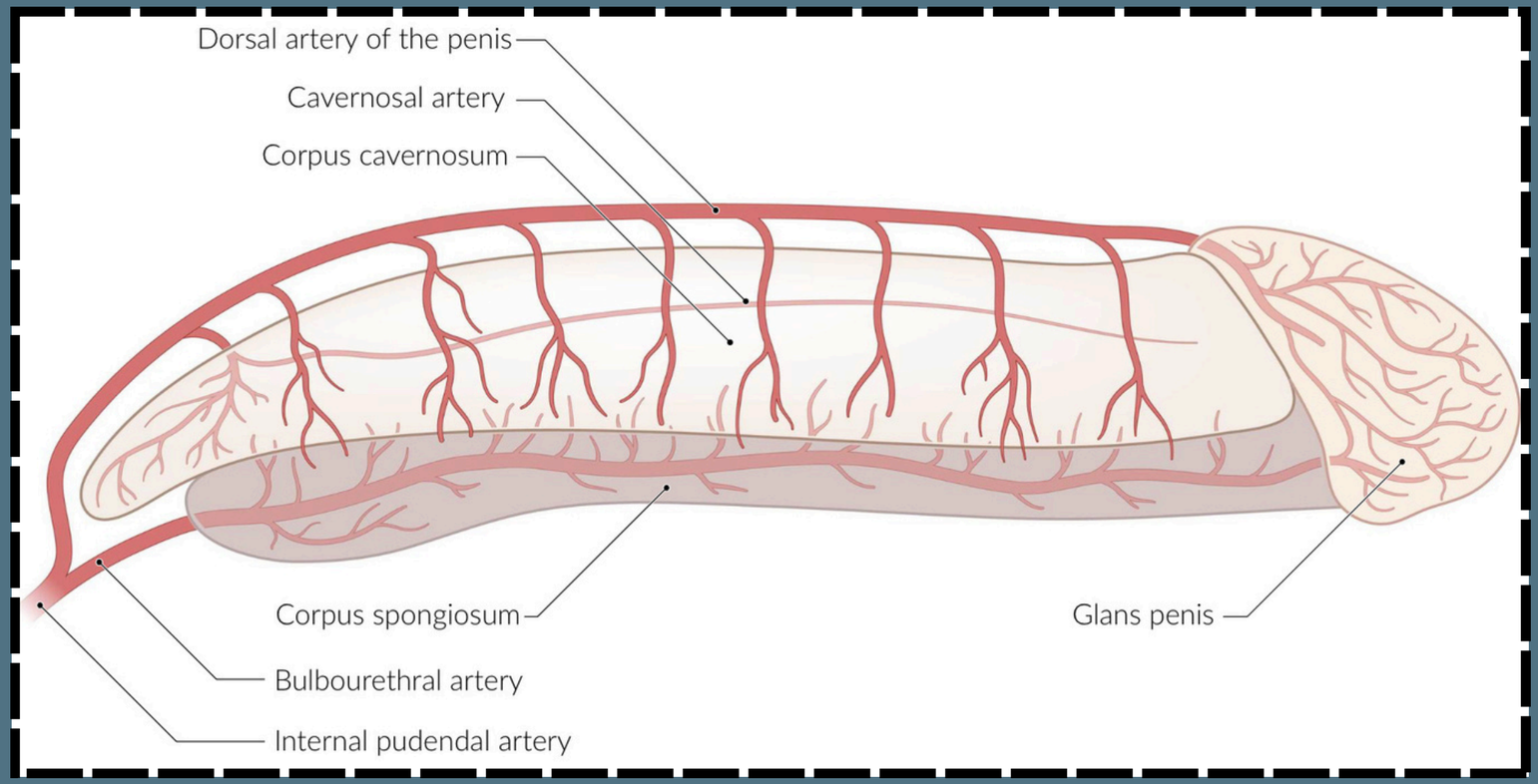


Anatomy


Superficial and deep dorsal veins of penis
Corpora cavernosa
Buck's fascia
Dartos fascia
Dorsal artery
Deep penile artery
Tunica albuginea
Areolar tissue
Urethra
Corpus spongiosum

ARTERIAL SUPPLY

The deep structures of the penis receive their blood supply from a continuation of the internal pudendal artery, which gives rise to three main branches supplying the penis:



ARTERIAL SUPPLY

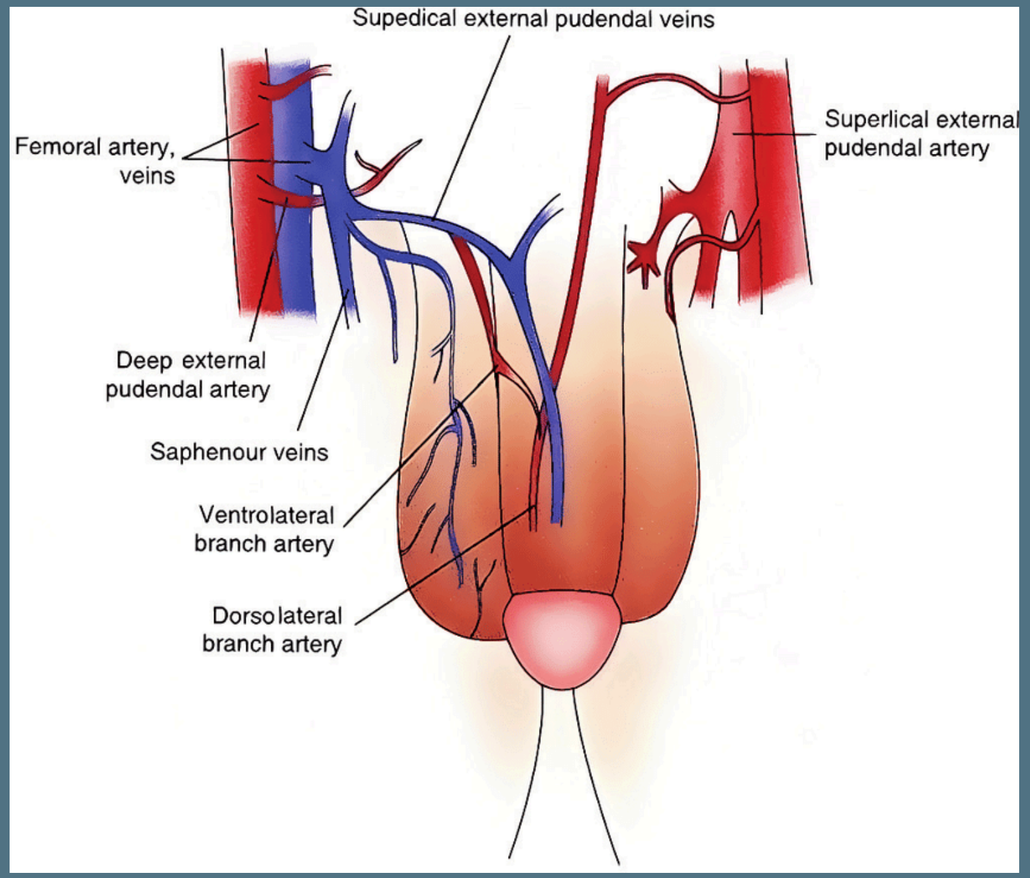
1. **Artery of the bulb (bulbourethral artery):**
- Passes through the deep penile (Buck's) fascia.
- Supplies the bulb of the penis and the penile (spongy) urethra.

2. **Dorsal artery of the penis:**
- Runs along the dorsum of the penis, positioned between the dorsal nerve and the deep dorsal vein.
- Gives off circumflex branches that accompany the circumflex veins.
- Its terminal branches supply the glans penis.

3. **Deep penile (cavernosal) artery:**
- Usually a single artery on each side.
- Enters the corpus cavernosum at the crus and runs along the shaft of the penis.
- Gives rise to the helicine arteries, which play a crucial role in the erectile process.

ARTERIAL SUPPLY

Additionally, the skin of the penis receives blood from the left and right superficial external pudendal arteries, both originating from the femoral artery.

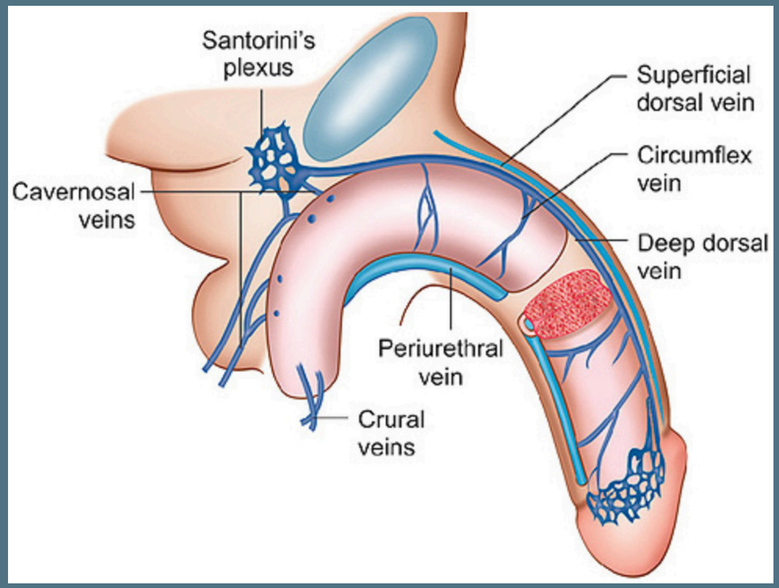


VENOUS DRAINAGE

The penis is drained by three venous systems: superficial, intermediate, and deep.

The superficial veins lie within the dartos fascia on the dorsolateral surface of the penis and converge at the base to form a single superficial dorsal vein, which typically drains into the great saphenous vein through the superficial external pudendal veins.

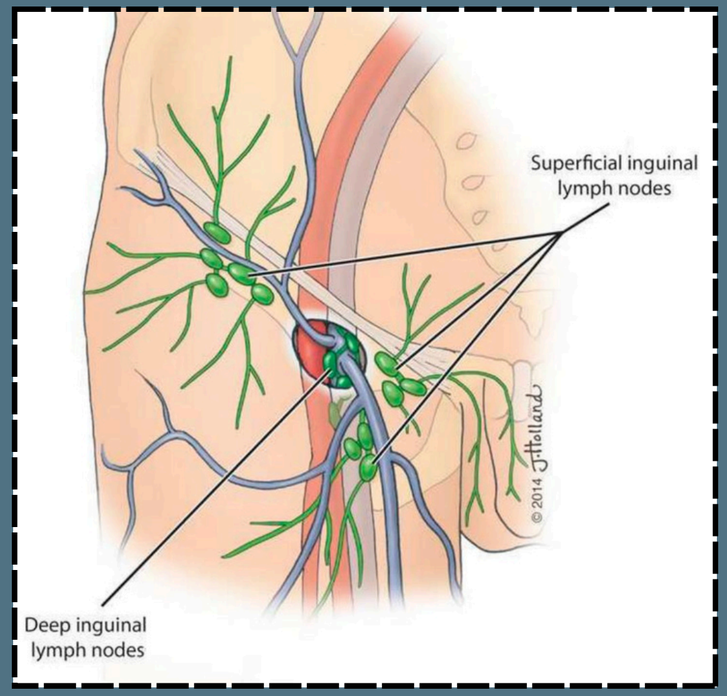
These superficial veins are the ones that become compressed to prevent venous outflow and thereby maintain penile engorgement.



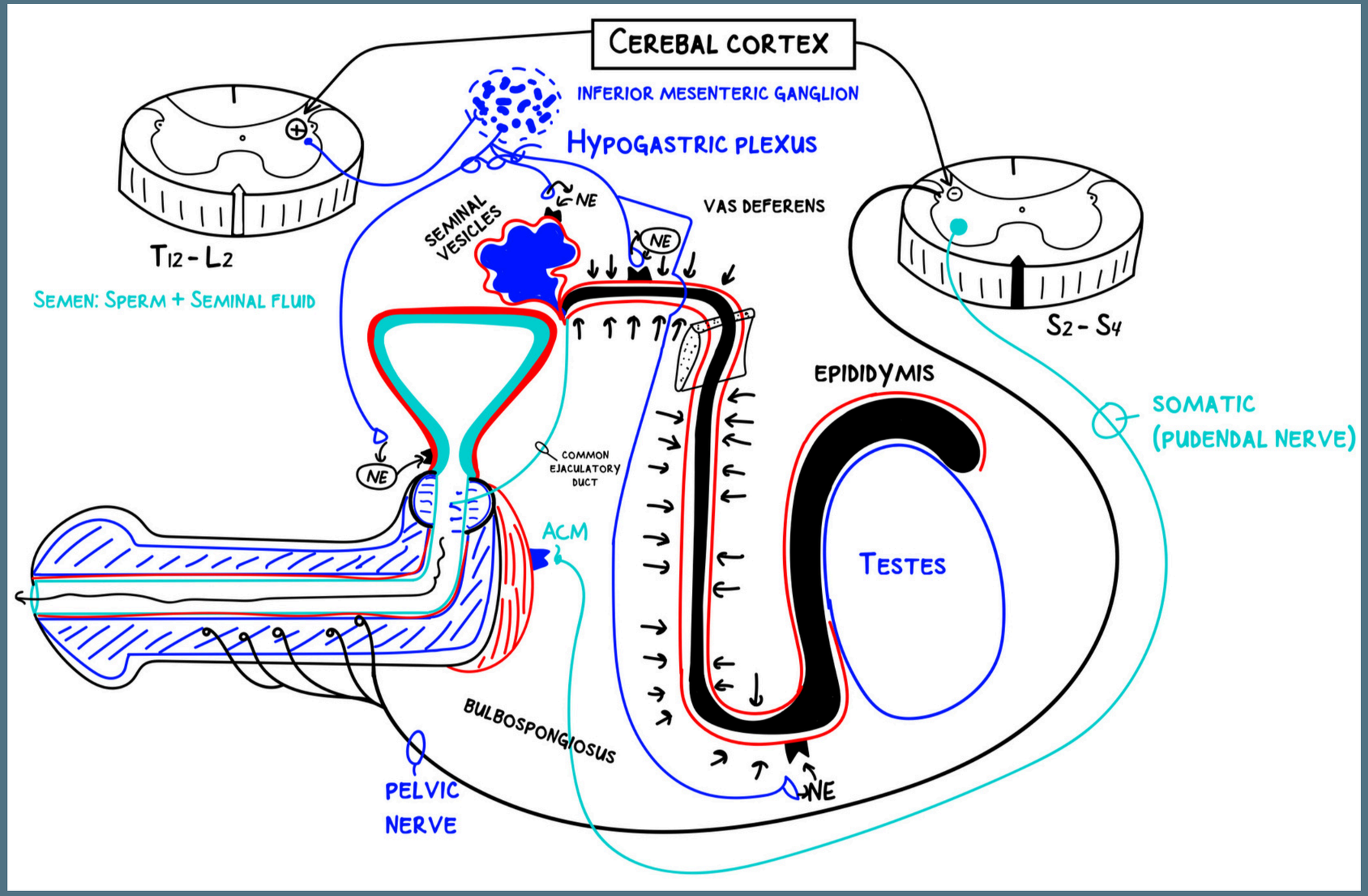
LYMPHATIC DRAINAGE

Lymphatic drainage from the glans penis primarily flows into the deep inguinal lymph nodes located within the femoral triangle.

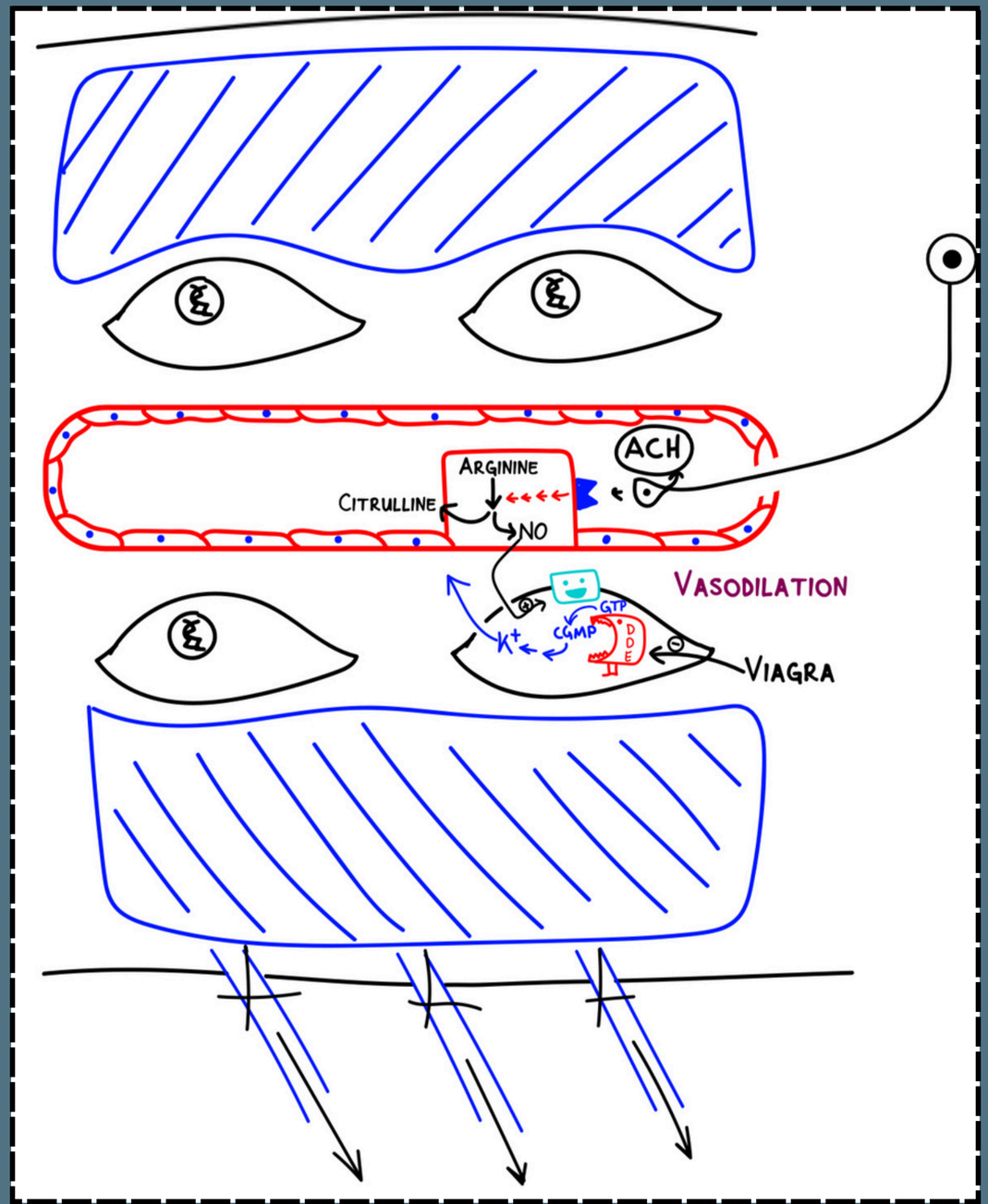
Additionally, some lymphatic vessels drain into the presymphyseal lymph nodes and the lateral external iliac lymph nodes.



MECHANISM OF ERECTION



MECHANISM OF ERECTION



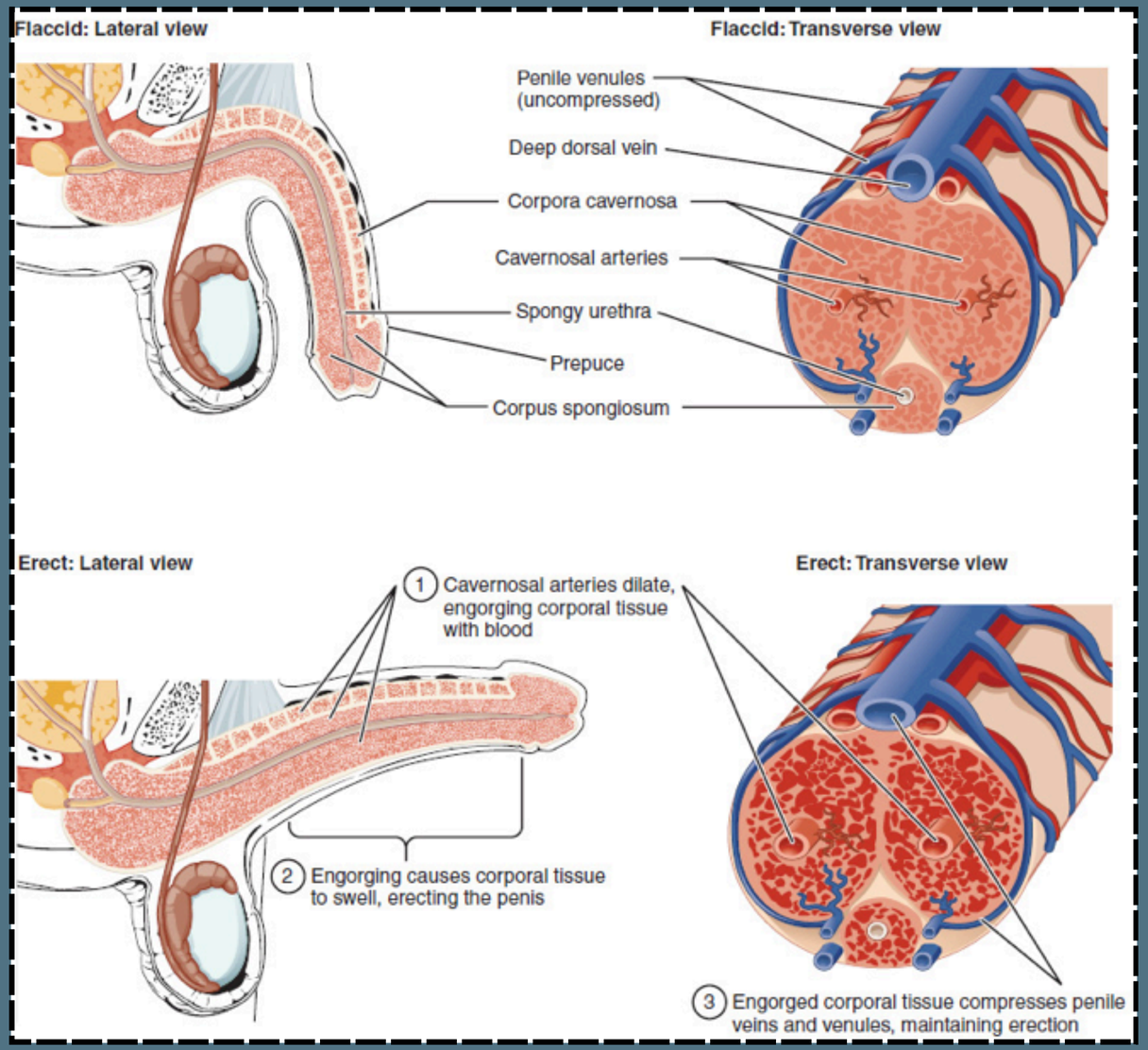
MECHANISM OF ERECTION

Neuroendocrine signals originating from the brain in response to audiovisual or tactile stimulation activate the autonomic nuclei within the spinal erection center.

These signals are transmitted through the cavernosal nerves to the erectile tissue of the corpora cavernosa, initiating the veno-occlusive mechanism that maintains penile rigidity.

Stimulation causes relaxation of the smooth muscle within the corpora cavernosa, leading to a significant increase in arterial blood flow.

MECHANISM OF ERECTION

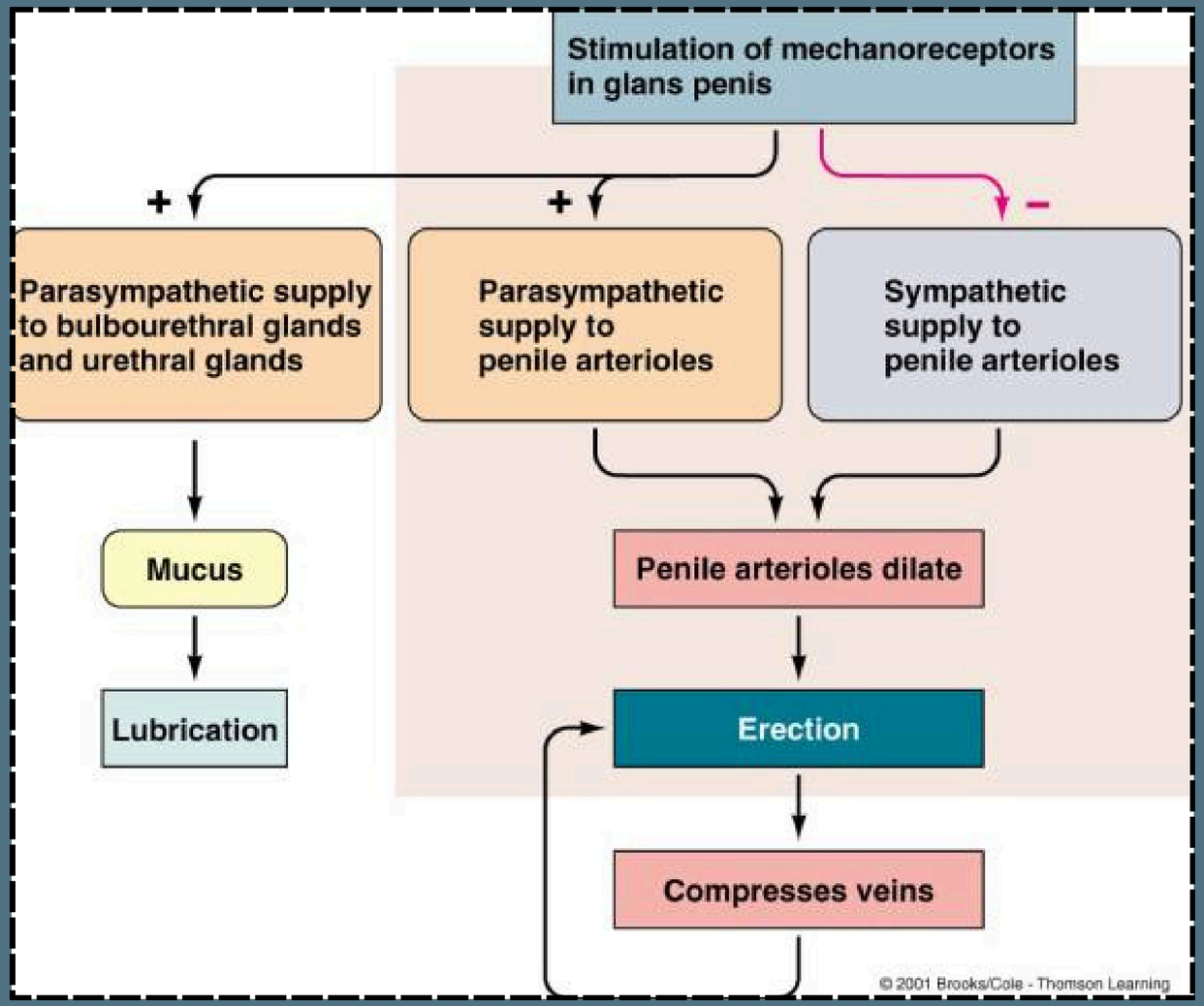


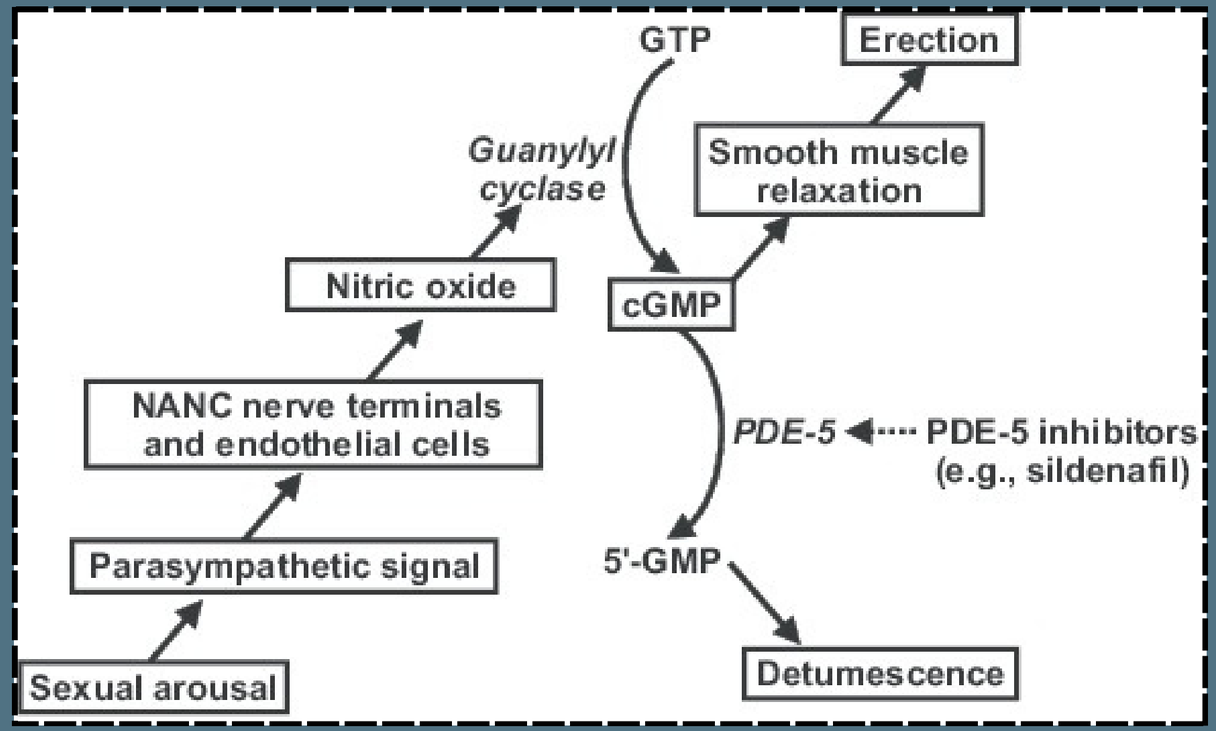
MECHANISM OF ERECTION

This process is mediated by nitric oxide (NO), which activates the enzyme guanylyl cyclase. This enzyme converts guanosine triphosphate (GTP) into cyclic guanosine monophosphate (cGMP). The increase in cGMP leads to smooth muscle relaxation by reducing intracellular calcium concentration, allowing vascular dilation and penile erection.

The duration of cGMP action is regulated by the enzyme phosphodiesterase (PDE)-specifically PDE-5, which is responsible for the breakdown of GMP within the corpus cavernosum, thereby terminating the erection.

MECHANISM OF ERECTION

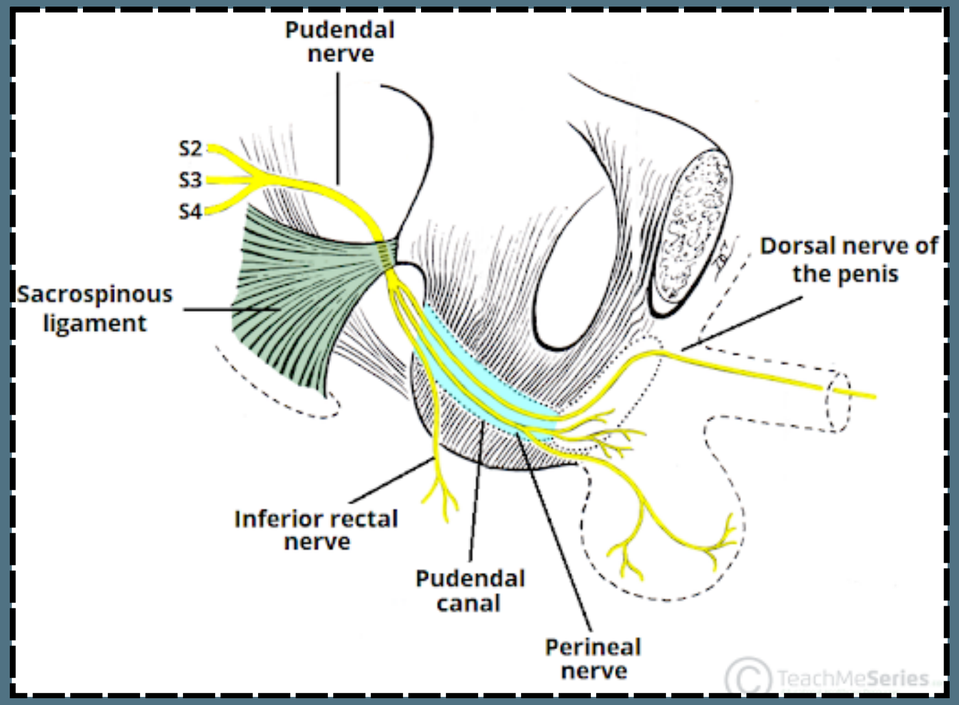




Innervation

1. Stimulation (Somatic Component)

Tactile stimulation of the genitalia is detected by sensory fibers of the pudendal nerve, which transmit impulses to the sacral spinal cord segments (S2-S4) to activate the spinal erection centers.



Innervation

2. Erection (Parasympathetic Component)

- **Origin**: Parasympathetic fibers arise from the lateral horns of the gray matter at spinal levels S2-S4.
- **Pathway**: Fibers travel through the pelvic splanchnic nerves to the preaortic and prostatic plexuses, then reach the penis.
- **Mechanism**:
- Nitric oxide (NO) is released, causing vasodilation of the deep penile arteries.
- This increases blood flow into the corpora cavernosa, resulting in engorgement of the erectile tissue.
- The expanding tissue compresses the draining veins, reducing venous outflow and sustaining erection.

Innervation

3. Emission (Sympathetic Component)

- **Definition:** The initial phase of ejaculation, involving the movement of semen into the prostatic urethra.
- **Origin:** Sympathetic fibers arise from the lateral horns of spinal segments T11-L2.
- **Pathway:** Fibers pass through the lumbar and sacral splanchnic nerves to the preortic plexuses, then to the ductus deferens and accessory glands.
- **Neurotransmitter:** Norepinephrine (NE).
- **Actions:**
- Produces peristaltic contractions of the ductus deferens, seminal vesicles, and prostate gland.
- Causes contraction of the internal urethral sphincter, preventing:
- Mixing of semen with urine.
- Retrograde flow of semen into the bladder.

Innervation

4. Ejaculation (Sympathetic + Somatic Components)

- **Sympathetic:** Maintains constriction of the internal urethral sphincter.

- **Somatic:**
- Impulses from the ventral horns of S2-S4 travel via the pudendal nerve.
- These impulses trigger rhythmic contractions of the bulbospongiosus and ischiocavernosus muscles, propelling semen out of the urethra.

5. Central Control

- Key hypothalamic centers:
- Medial preoptic area (MPOA).
- Paraventricular nucleus (PVN).

- These regions play essential roles in sexual arousal, penile erection, and coordination of autonomic and somatic responses.

PHASES OF ERECTILE PROCESS (HEMODYNAMIC PHASES)

Phases	Phase Name	Description
0	Flaccid phase	Cavernosal smooth muscle contracted; sinusoids empty; minimal arterial flow
1	Latent (filling) phase	Increased pudendal artery flow; penile elongation.
2	Tumescent phase	Rising intracavernosal pressure; erection forming.
3	Full erection phase	Increased cavernosal pressure causes penis to become fully erect.
4	Rigid erection phase	Further increases in pressure + ischiocavernosal muscle contraction.
5	Detumescence phas	Following ejaculation, sympathetic discharge resumes; there is smooth muscle contraction and vasoconstriction; reduced arterial flow; blood is expelled from sinusoidal spaces.

ERECTILE DYSFUNCTION

DEFINTION

Erectile dysfunction (ED), also known as impotence, is the consistent or recurrent nability to get or maintain an erection firm enough for satisfactory sexual intercourse.

ERECTILE DYSFUNCTION

EPIDEMOLOGY

The prevalence of erectile dysfunction (ED) increases significantly with age

In men aged 40–70:

52% have some degree of ED.
17% have mild ED.
25% have moderate ED.
10% have complete ED.

Incidence of complete ED:

Affects 15% of men in their 70s.
Affects 30–40% of men in their 80s

AETIOLOGY ERECTILE DYSFUNCTION

AETIOLOGY

The causes of erectile dysfunction are broadly classified into two main categories: psychogenic and organic. However, it is important to note that many cases are multifactorial, involving a combination of both.

	Psychogenic	Organic
Proportion	10%	90%
Onset	Sudden	Gradual
Frequency	Sporadic	All circumstances
Variation	With partner and circumstance	No
Age	Younger	Older
Organic Risk Factors (HTN, DM, Dyslipidemia)	No organic risk factors	Risk factors present
Nocturnal/AM erection	Present	Absent

*Key Clinical Considerations

- Nocturnal/AM Erections: The presence of spontaneous nocturnal or morning erections is a key sign that the underlying physical "machinery" is functional, strongly pointing toward a psychogenic cause.
- Onset of Organic ED: While typically gradual, a sudden onset of organic ED can occur following an obvious cause, such as pelvic surgery or trauma.
- Associated Functions: In many cases of organic ED, libido (sex drive) and ejaculatory function remain intact

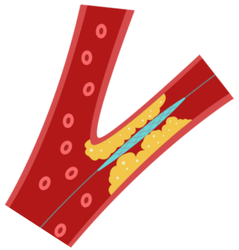
AETIOLOGY ERECTILE DYSFUNCTION

AETIOLOGY

VASCULAR

- Atherosclerotic cardiovascular disease (ASCVD), e.g., Leriche syndrome.
- ASCVD risk factors:

1. Smoking
2. Hyperlipidemia
3. Diabetes mellitus
4. Hypertension



ENDOCRINOLOGIC

- Hypogonadism
- Hyperprolactinemia
- Thyroid disorders

PSYCHOLOGICAL / PSYCHIATR

- Stressors: Relationship problems
- ,Traumatic experiences,Major life
- events.....
- Psychiatric disorders: MDD,
- anxiety disorder, (PTSD)...

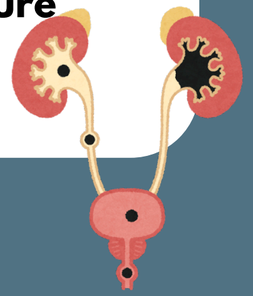
1.

NEUROLOGICAL

- Stroke
- Brain or spinal cord injury
- Dementia
- Parkinson’s disease
- Multiple sclerosis
- Pelvic fracture or pelvic surgery (e.g., radical prostatectomy)

UROLOGICAL / PENILE

- Peyronie’s disease
- Urethral injury
- Penile fracture



MEDICATIONS/ SUBSTANCE USE

- Dopamine antagonist
- Antidepressants (e.g., SSRIs)
- Antihypertensives (e.g., beta-
- blockers, thiazide diuretics)
- Heavy alcohol use
- Recreational drug use

Sexual History:

1. Onset of erectile dysfunction (ED): sudden vs. gradual.
2. Duration and progression of the problem.
3. Presence of erections: nocturnal, early morning, or spontaneous erections.
4. Quality and maintenance of erections: early loss, inability to achieve full rigidity.
5. Libido changes.
6. Relationship and sexual activity: frequency of intercourse, sexual desire, partner factors.

Medical and Surgical History:

1. Assess risk factors: diabetes mellitus (ED occurs in ~50% of men with diabetes and ~30% of those on treatment), cardiovascular disease, hypertension,
2. peripheral vascular disease.
3. Endocrine or neurological disorders.
4. History of pelvic or penile surgery, radiotherapy, or trauma (may affect innervation or blood supply).

Psychosocial History:

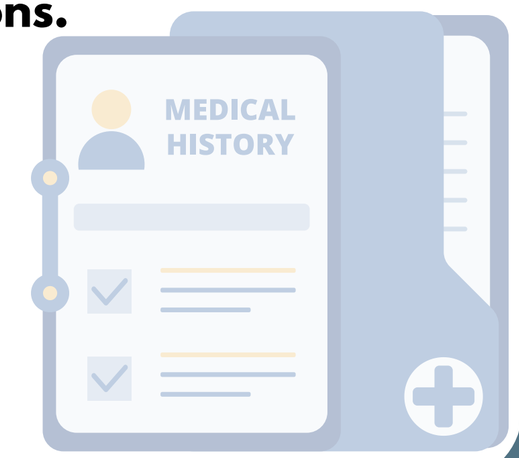
1. Evaluate stress, anxiety, depression, coping mechanisms, and patient expectations.
2. Consider relationship factors affecting sexual function

Medications and Treatments:

Current medications (including antihypertensives, antidepressants, etc.).
Prior ED treatments and their outcomes.

Lifestyle Factors:

Smoking, alcohol, recreational drug use.



- **Systemic Examination:**

A full cardiovascular, abdominal, and neurological assessment should be performed to look for signs of vascular disease or nerve-related issues.

- **Genital & Hormonal Assessment:**

Assess secondary sexual characteristics (e.g., hair distribution, gynecomastia) for clues about hormonal status.

- **Examine the external genitalia to document:**

Foreskin phimosis (a tight foreskin).
Penile deformities or lesions, such as Peyronie's plaques (hardened tissue causing curvature).
The presence, size, and location of the testicles (small testes may suggest low testosterone).

- **Prostate Assessment:**

A Digital Rectal Exam (DRE) is performed to assess the prostate gland

- **Blood Tests (Basic Work-up): (Mandatory)**

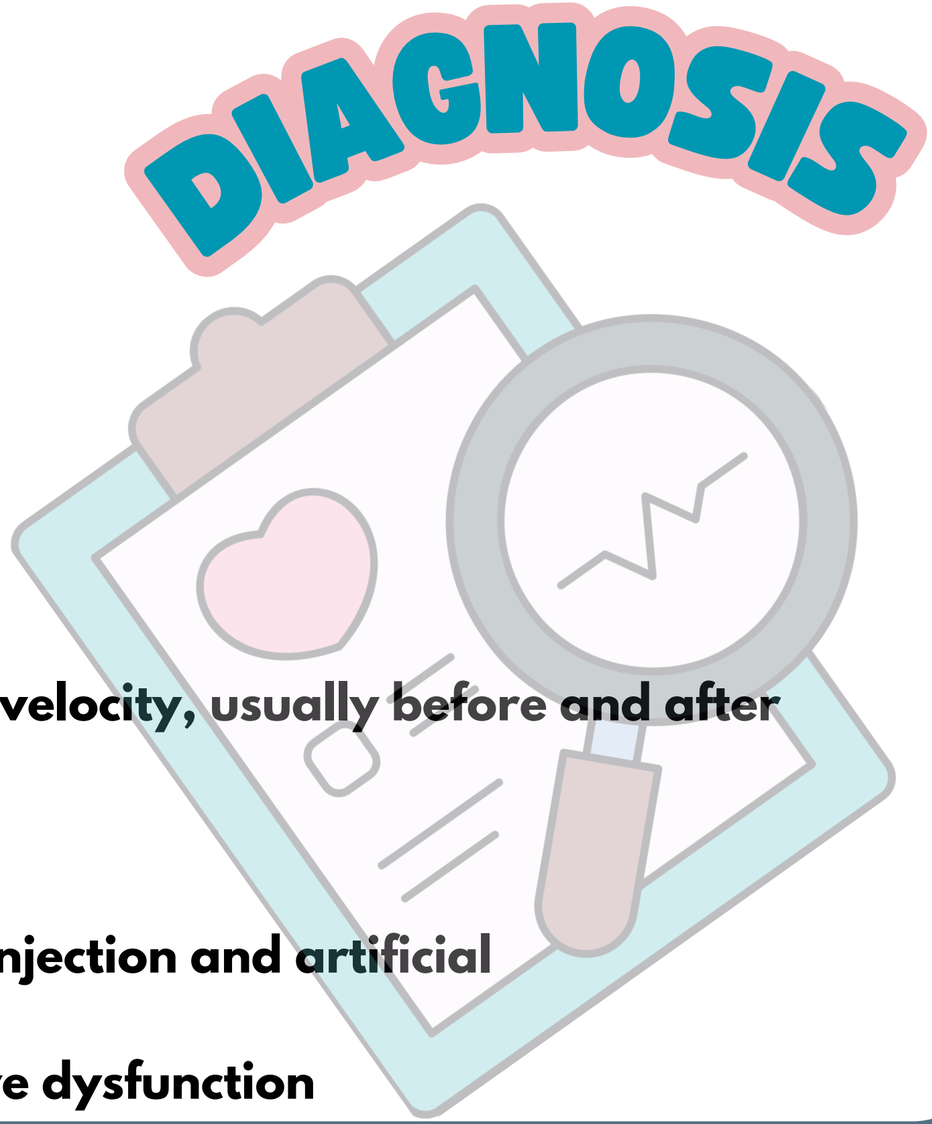
1. Fasting glucose (screen for diabetes)
2. Serum total and/or free testosterone (ideally between 8:00–11:00 a.m.) ,< 300
3. ng/dL indicates testosterone deficiency
4. Fasting lipid profile (assess cardiovascular risk)
5. Selective (based on history/risk factors):
   - Sex hormone-binding globulin (SHBG)
   - Urea and electrolytes (U&E)
   - LH, FSH (evaluate hypogonadism)
   - Prolactin (if hypogonadism suspected)
   - PSA (if indicated, usually in older men)
   - Thyroid function tests

- **Penile Colour Doppler Ultrasound (USS):**

1. Measures arterial peak systolic velocity and end-diastolic velocity, usually before and after intracavernosal PGE1 injection
2. Assesses arterial inflow and veno-occlusive function.

- **Cavernosography:**

1. Evaluates penile blood flow after intracavernosal contrast injection and artificial erection
2. Mainly used to detect venous leak in cases of veno-occlusive dysfunction



DIAGNOSIS

- **Nocturnal Penile Tumescence (NPT) Testing:**

1. Performed with Rigiscan device, which
2. measures:
3. Number, duration, and rigidity of nocturnal
4. erections
5. Useful for distinguishing psychogenic ED
6. from organic causes and for patient
7. education.

- **Penile Arteriography:**

1. Reserved for trauma-related ED,
2. particularly in younger men
3. Pudendal arteriography performed pre-and post-drug-induced erection to identify candidates for arterial bypass surgery
1. Less commonly performed today due to advances in penile prostheses.

- **MRI:** 
- Useful for assessing penile fibrosis and severe Peyronie’s disease

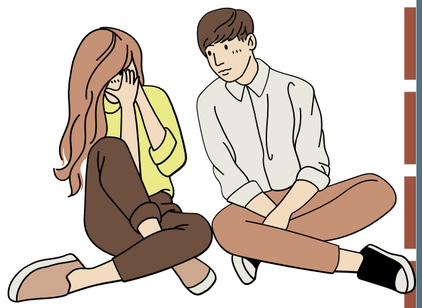
MANAGEMENT OF ERECTILE DYSFUNCTION

“Erectile dysfunction is not just a sexual problem — it’s a vascular and psychological mirror of overall health.

So, before treating the symptom, we must understand the system.”

Full Treatment Ladder for Erectile Dysfunction :

1.Lifestyle Optimization & Risk Control
2.Psychosexual Counseling
3.PDE5 Inhibitors
4.Local & Mechanical Therapies (ICI / MUSE / VED)
5.Surgical Options (Prosthesis / Vascular)
6. Hormonal Therapy (TRT)



1 LIFESTYLE MODIFICATION & RISK CONTROL:

ED is often a vascular manifestation of systemic disease. Fixing risk factors may reverse the dysfunction:

Action	Mechanism	Clinical Impact
Quit smoking	Restores endothelial NO	Improves function in 3 months
Weight loss & exercise	Decrease inflammation,increase testosterone	Strongest modifiable factor
Control diabetes & BP	Prevents endothelial damage	Protects vasculature
Better sleep & stress control	Decrease sympathetic tone	Enhances libido
Review medications	Avoid Î²-blockers, SSRIs	Remove iatrogenic causes

2 PSYCHOSEXUAL THERAPY:

Therapy Elements:

- **Education: normalize expectations and reduce anxiety.**
- **Cognitive Behavioral Therapy: break fear–failure cycle.**
- **Couple counseling: rebuild emotional connection.**
- **Treat depression/anxiety if present (use non-sexual-suppressing agents).**

notes

Lifestyle modification should always precede or accompany pharmacologic therapy.

Around 25% of mild ED cases improve within three months after lifestyle correction — no pills, just physiology.

An anxious mind blocks a parasympathetic response.

Once relaxed, the physiology works naturally.”

3 PHARMACOLOGY:

- PDE5 Inhibitors: Sildenafil (Viagra), Vardenafil (Levitra), Tadalafil (Cialis), Avanafi(Stendra)

  “All PDE5 inhibitors are safe, effective, and first-line in the absence of contraindications.”

- Mechanism of Action :
  Inhibit phosphodiesterase-5, the enzyme that degrades cGMP—> smooth-muscle relaxation persists —> stronger erection.

- Requires sexual stimulation for activation of NO release.

  NO —>↑cGMP —> PDE5 inhibitor —>prevents breakdown of cGMP —> sustained erection.

- Common adverse effects:
  1) Flushing 2)Headache 3)Dyspepsia 4)Nasal congestion 5)Visual hue change (sildenafil)

- Contraindications :
  1)Concomitant nitrate use (any form of nitroglycerin) —> severe life-threatening hypotension.

  2) Recent (< 6 months) myocardial infarction, stroke, or life-threatening arrhythmia.

  3) Unstable angina or severe heart failure (NYHA III–IV).

  4) Severe hypotension (SBP < 90 mmHg / DBP < 50 mmHg).

  5) Known hypersensitivity to drug component.

  6) Concurrent α-blocker therapy (e.g. tamsulosin, doxazosin) must separate(≥ 4 h) to avoid orthostatic hypotension.

Only Daily low-dose Tadalafil = best option for long-term penile(vascular) rehabilitation especially after BPH

PHARMACOLOGY:

- **Apomorphine :**

A centrally acting dopamine (D2) receptor agonist used previously for erectile dysfunction.
It is taken sublingually and works by stimulating dopaminergic receptors in the paraventricular nucleus of the hypothalamus, enhancing the response to sexual stimuli.
Side effects: nausea, headache, dizziness.
Notes: Not commonly used today due to limited efficacy and adverse effects.

---

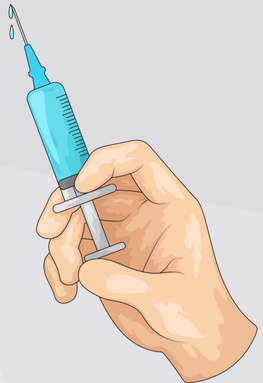
4 LOCAL & MECHANICAL THERAPIES (ICI / MUSE / VED):

- **Local therapy:**

“These options directly target the penis, by passing the central neurovascular control.”

Move to local therapy when there is failure or contraindication of PDE5 inhibitors,
or if the patient prefers non-oral or faster methods.

- **Main Options :**
  - Intracavernosal injection (ICI)
  - Intraurethral alprostadil (MUSE)
  - Vacuum erection device (VED)



INTRACAVERNOSAL INJECTION (ICI):

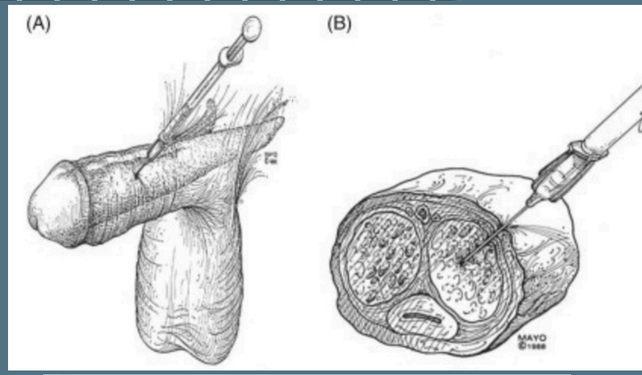
The most effective nonsurgical option, and it works even when the nerve pathway is damaged.

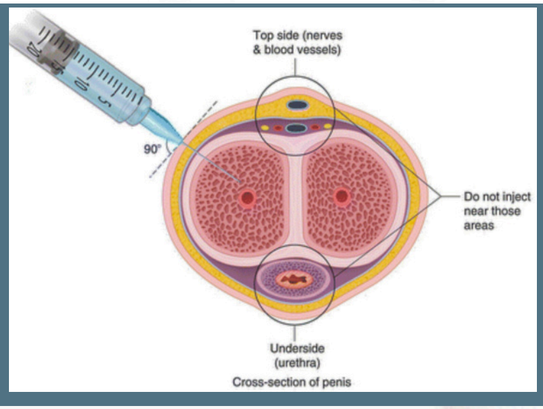
Mechanism of Action:
Direct smooth-muscle vasodilation -> erection in 10-15 min independent of neural pathway

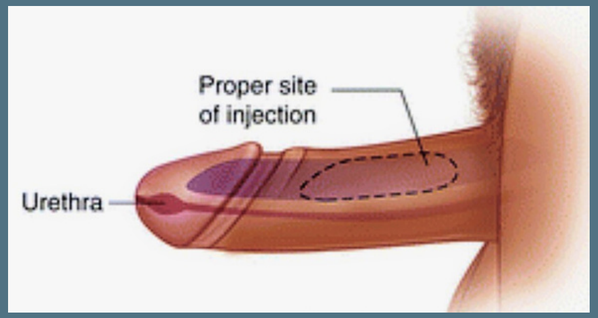
Technique:
Inject laterally at 10 or 2 o'clock positions on the shaft.
Compress site for 2-3 minutes after.
First injection should always be supervised.

Agents:
-Alprostadil (PGE1) : increases cAMP, relaxes cavernosal muscle.
-Papaverine : non-selective PDE inhibitor.
-Phentolamine : a-blocker (synergistic effect).
-Trimix (PGE, + Papaverine + Phentolamine) : highest efficacy (~85%).

Adverse effects:
Mild pain, hematoma, fibrosis, and priapism(rare <1%).



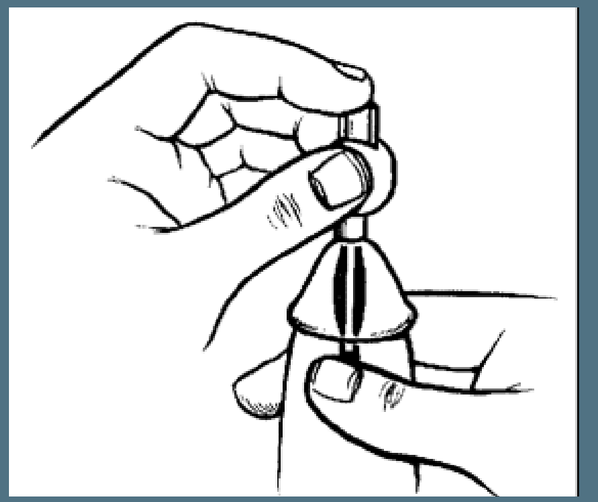




INTRAURETHRAL ALPROSTADIL (MUSE):

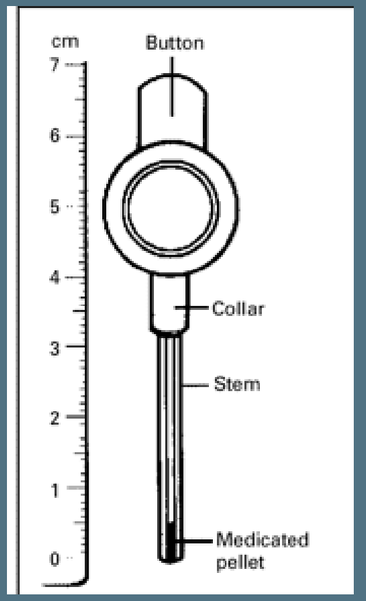
Mechanism of Action:

Tiny pellet (125-1000 µg PGE1) inserted 3 cm into urethra -> absorbed ->cavernosal vasodilation.



Advantages:

1) Non-invasive.
2) Rapid onset (10-15 min).



Limitations:

-Less effective (40-50%).
-Burning sensation, minor bleeding.
-Condom use recommended (partner safety).

VACUUM ERECTION DEVICE (VED)

Mechanism of Action:
Creates negative pressure-> blood drawn into corpora -> constriction ring traps blood.

Uses:

1) Safe for cardiac or elderly patients.
2)Penile rehabilitation after prostatectomy (preserves tissue oxygenation).

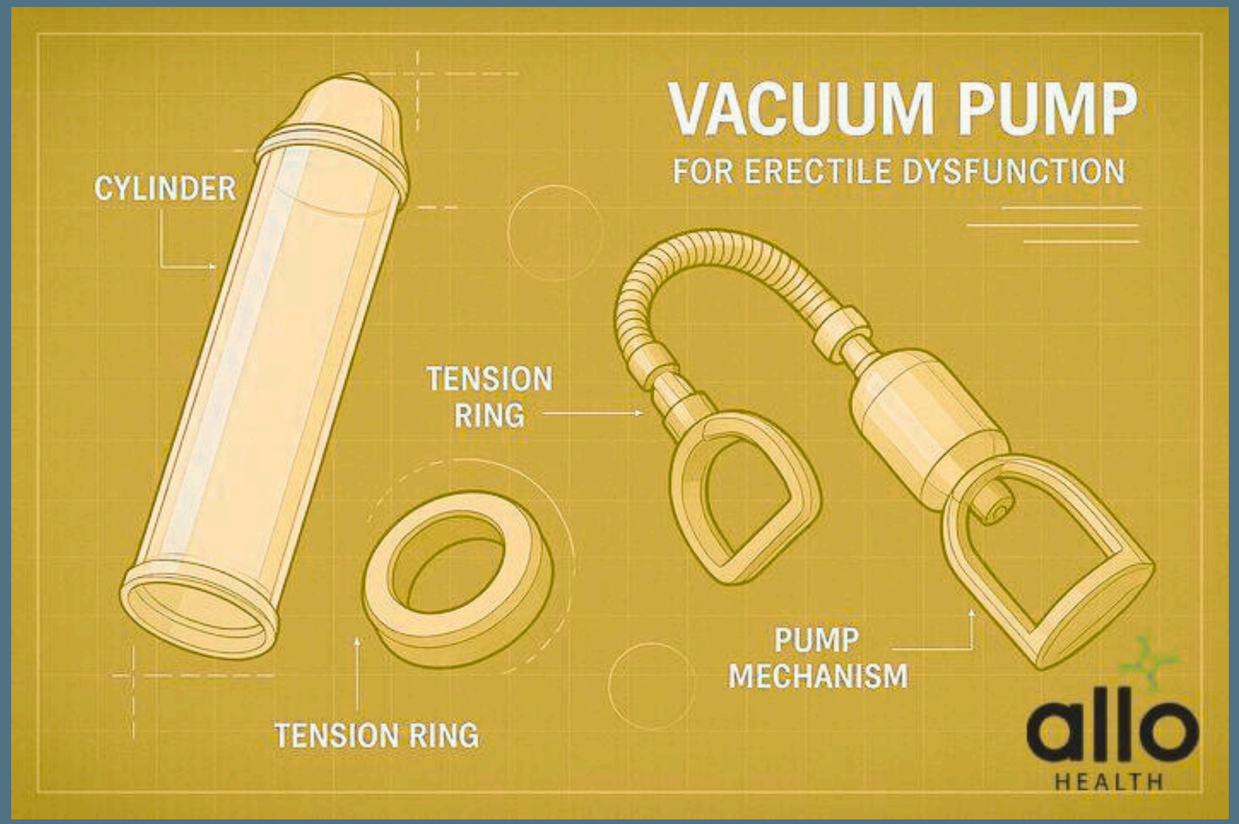
Advantages:

- 70-80% satisfaction rate.
- Simple, mechanical, reusable.

Dis & contraindications :

- Cold sensation, numbness, bruising
- Anticoagulation or bleeding disorders.

Note:
"VED is not just therapy — it's prevention against fibrosis when used after prostate surgery."



5 SURGERY

Move to surgical therapy after failure or contraindication of conservative and pharmacologic therapies, or if the patient prefers a definitive solution.

Main options:

1)Penile prosthesis implantation (mainstay)

2)Vascular reconstructive surgery (rare)

Penile Prosthesis Implantation (Definitive Surgical Treatment):

Concepts: Surgical implant placed inside the corpora cavernosa to restore erectile rigidity in men with irreversible ED.

does not affect orgasm or ejaculation — only restores the mechanical erection.

Indications:

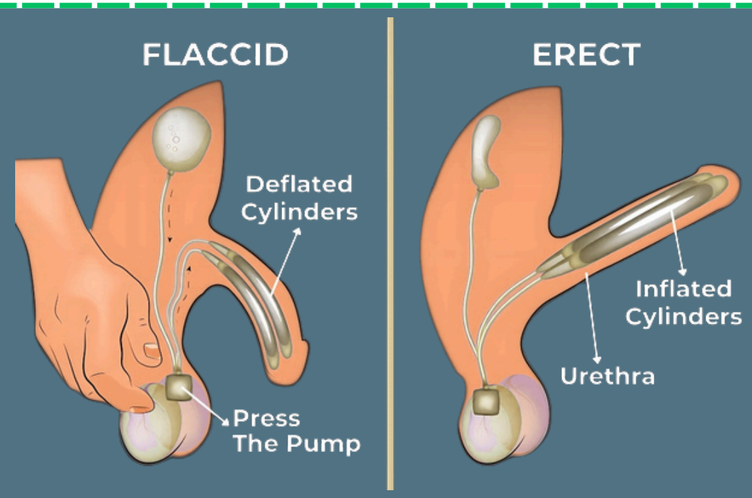
1)Failure of all conservative treatments.

2)Post-prostatectomy or spinal injury with irreversible neurogenic ED.

3)Severe fibrosis or trauma (Peyronie's disease with ED).

Contraindications :

Active infection, poorly controlled diabetes (T risk of infection), severe psychiatric or cognitive disorder.



Complications:

-Infection (1-3%)

-mechanical failure (5-10% over 10yrs)

-erosion (<2%).

SURGERY

Penile Prosthesis Implantation (Definitive Surgical Treatment):

Types of Penile Prostheses:

i.Malleable (Semi-Rigid) Prosthesis:

Two flexible rods are implanted within the corpora cavernosa.

These rods are made of silicone with a metal or polymer core that allows bending, and the patient manually positions the
penis upward for intercourse and downward afterward.

Mechanism Summary:
★Constant rigidity—>manual angulation control
★no hydraulic system(no fluid or pump)

ii.Inflatable Prosthesis (2 subtypes):

Two-piece system
Three-piece system (most common)

Mechanism Summary:
ClinicalPearl: Inflatable prostheses (hydraulic system) are considered the gold standard today.

They restore both rigidity and flaccidity,closely mimicking natural function.

SURGERY

Microvascular (arterial bypass & venous ligation):

- Surgical options used only in specialized centers for patients with a clearly diagnosed vascular cause of erectile dysfunction.
- They aim to increase arterial inflow and reduce venous outflow.
- Rarely performed now, as success rates are generally below 50%.

6 HORMONAL THERAPY:

Testosterone Replacement Therapy:

Low testosterone impairs libido, mood, and cavernosal function.
Replacing it restores the hormonal and vascular balance — but only when truly deficient.

Mechanism of Action

★Increases NO synthase in cavernosal tissue improves -> erection quality.
★Enhances libido and sexual motivation.
-Potentiates response to PDE5 inhibitors (“dual therapy concept”).
TRT -> ⇑NO synthase -> ⇑cGMP improved erection

Indications :

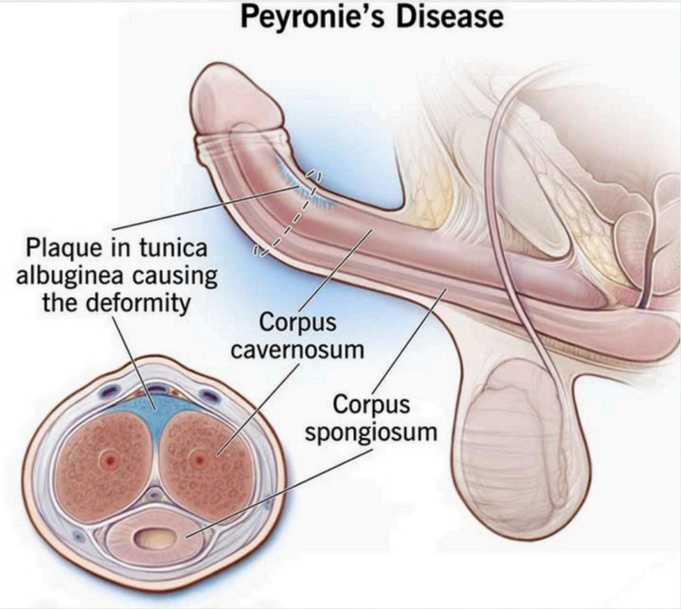
- Symptoms of androgen deficiency (fatigue, low libido,depressed mood)
- Low testosterone on two morning samples (8–11 AM)
  <12 nmol/L (350 ng/dL): borderline
  <8 nmol/L (230 ng/dL): diagnostic

Rule out :

-prostate cancer
- sleep apnea
- severe heart failur
(Due to fluid retention)

• PEYRONIE'S DISEASE (PD):

- **Definition : Localized fibrotic disorder of tunica albuginea -> plaque formation->penile curvature ± ED.**
- **It's basically a scar that healed in the wrong direction turning flexibility into curvature**



- **Phases:**

- **Active (pain, progressive curve) medical therapy :**
- This stage lasts about 6–18 months and is characterised by penile pain, progressive curvature, and plaque development, with the curvature usually worsening during this period
- **Stable (no pain, fixed deformity) – surgical correction:**
- Pain subsides and the curvature becomes fixed, while the plaque becomes calcified and the deformity no longer progresses, though erectile dysfunction may persist due to structural or psychological causes.

- **Diagnosis : mainly clinical, based on history and physical examination:**
- A palpable hard plaque on the shaft with visible curvature during erection can be evaluated using ultrasound or Doppler to assess plaque size, calcification, and vascular function.

• PEYRONIE'S DISEASE (PD):

- **Management**

1) Intralesional therapy:

Collagenase (CCH / Xiapex): enzymatically breaks down plaque collagen; given as 2 injections per cycle and may reduce curvature by ~30°.

Verapamil or Interferon-α2b: decrease fibroblast activity and collagen production.

NSAIDs: used for pain control during the active, inflammatory phase.

---

2) Surgical therapy (stable phase):

Reserved for patients with stable penile deformity ⩾3 months and significant functional impairment.

Options include: tunical plication (Nesbit procedure), plaque incision with grafting, and penile prosthesis implantation

THANKS FOR YOUR ATTENTION!