



## Pharmacology Of Drugs Acting On the Eye

### Objectives:

- Outline common routes of administration of drugs to the eye.
- Discuss the pharmacokinetics of drugs applied topically to the eye.
- Classify drugs used for treatment of disorders of the eye.
- Outline ocular toxicity of some drugs.
- Elaborate on autonomic drugs, anti-inflammatory drugs, and drugs used for glaucoma.

### Color index:

- Drugs names
- Doctors notes
- Important
- Extra

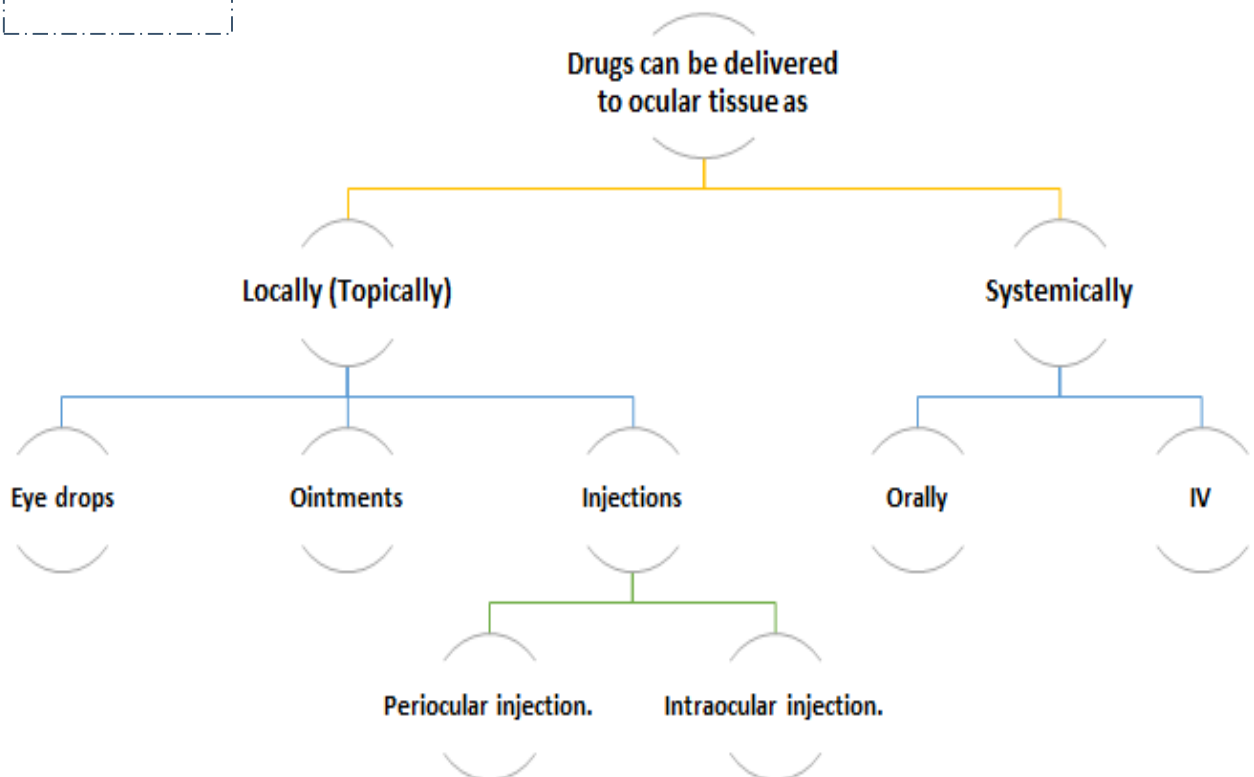
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وأن أثابر في طلب العلم: أسخره لنفع الإنسان

# Overview

Eye		Sympathetic N.S. (far vision)	Parasympathetic N.S. (near vision)
Iris:	- radial muscle	Contraction (Mydriasis) ( $\alpha 1$ ) <b>Active mydriasis</b>	No effect
	- circular muscle	No effect	Contraction (miosis) (M3)
Ciliary muscle		Relaxation ( $\beta 2$ )	Contraction (M3)
Lens		Thin, more flat	Thick, more convex
Suspensory ligaments		Contraction	relaxation
Conjunctival blood vessels		Conjunctival Vaso <u>con</u> striction ( $\alpha 1$ )	Conjunctival Vaso <u>dila</u> tation

Team 436



# Pharmacology of drugs acting on the eye

Drugs can be delivered to ocular tissue as:

Locally (Topically): *more common*	Systemically:
<ul style="list-style-type: none"> <li>- Eye drops.</li> <li>- Ointments.</li> <li>- Injections:                             <ul style="list-style-type: none"> <li>→ Periocular injection. (the name referred to site of injection)</li> <li>→ Intraocular injection.</li> </ul> </li> </ul> <p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>- Convenient (مريح), Economic (رخيص), Relatively safe.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>- Compliance, Corneal &amp; conjunctival toxicity.</li> </ul>	<ul style="list-style-type: none"> <li>- Orally</li> <li>- IV</li> </ul>

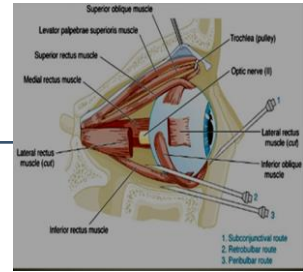
First – **locally:**

	Ointment (مرهم)	Eye drops (high frequency we want the drug to contact with ocular tissue)
<b>Definition</b>	<p>Ointment is a smooth oily preparation, As a rule of thumb, an ointment base is more occlusive and will drive the medication into the skin more rapidly than a solution or cream base. (used once a day, because it has long time to contact with eye)</p>	<ul style="list-style-type: none"> <li>• Eye drops are saline-containing drops "liquid"</li> <li>• <b>Most common route of administration.</b> (have adherence)</li> <li>• One drop = 50 µl / 4 hours (usually)</li> </ul>
<b>Advantages</b>	<p>Increases the <b>contact time</b> of ocular medication to ocular surface → providing <b>better effect.</b></p>	-----
<b>Disadvantages</b>	<p>The drug has to be <b>high lipid soluble</b> (to penetrate) to have the maximum effect as ointment. (low molecular weight)</p>	<p>The contact time between the drug and the eye is <b>low</b> due to fast removal by tears. → Thus has to be used <b>several times.</b></p>



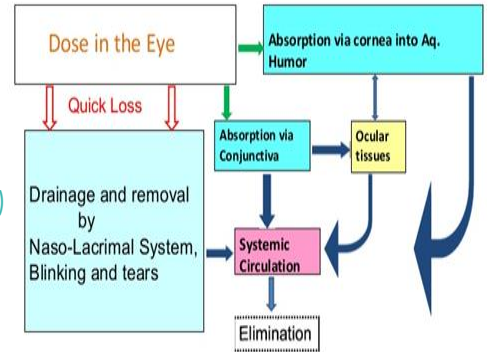
## Eye injections:

		Uses	ADRs		
<b>Intraocular Injections</b>	Intra:Intra	1-intra-cameral: "inside anterior or posterior chamber of the eye"  0:23 min	E.g. <ul style="list-style-type: none"> <li>Intracameral <b>acetylcholine</b> or <b>lidocaine</b> during cataract surgery.</li> </ul>	-Anterior segment surgery -Infection -Retinitis	- Retinal toxicity. - Intraocular toxicity. - Corneal toxicity.
		2- Intra-vitreous "inside the eye"(vitreous humor)  3:06 min	E.g. <ul style="list-style-type: none"> <li>Intravitreal <b>antibiotics</b> in cases of <b>endophthalmitis</b> (an inflammation of the internal coats of the eye)</li> <li>Intravitreal <b>steroid</b> in <b>macular edema</b> (the build-up of fluid in the <b>macula</b>, an area in the center of the retina.)</li> </ul>		
<b>Techniques</b>	<b>Periocular Injections</b>	1- Subconjunctival  0:4 min			
		2- Retrobulbar "behind the eyeball"  0:34 min			
		3- Peribulbar "above and below the orbit"			
		4- Subtenon  0:41 min			
		<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>- Reach <u>behind</u> iris-lens diaphragm <b>better than</b> topical application.</li> <li>- <u>Drugs penetration is generally weaker for low lipid-soluble drugs</u>, however injections can bypass the conjunctival and corneal epithelium which is good for <b>drugs with low lipid solubility (e.g. penicillins)</b> [Hydrophilic drugs]</li> <li>- <b>Steroid and local anesthetics</b> can be applied this way.</li> <li>- Used for infection of anterior segment and inflammation of uvea.</li> </ul>			
		<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>- Local toxicity, tissue injury, globe perforation, optic nerve damage.</li> </ul>			



# Pharmacokinetics of topical drugs:

Absorption	<p><b>Drug residence time</b> → the <u>rate</u> of absorption is determined by the time drug remains in cul-de-sac, tear. It can be prolonged by plugging tear ducts or change formulation. (residence time = the time in which drug will still in the eye).</p> <p><b>Metabolism:</b> Significant biotransformation takes place in the eye.</p> <p><b>Esterases</b> activate pro-drugs, e.g.:</p> <ul style="list-style-type: none"> <li>- <b>Dipivefrin</b> (inactive form) → (adrenaline) (active form)</li> <li>- <b>Latanoprost</b> → (PGF2a)</li> </ul> <div style="border: 1px dashed gray; padding: 5px; width: fit-content; margin: 10px auto;">Dipivefrin: Adrenaline</div> <p><b>Elimination</b> → by <b>nasolacrimal</b> drainage or binding to tear protein.</p> <p><b>Diffusion</b> → across cornea &amp; conjunctiva.</p>
Distribution	<ul style="list-style-type: none"> <li>- After corneal absorption → the drug accumulates in the <b>aqueous humor</b>, intraocular structures or systemically distributed.</li> <li>- <b>Melanin</b> binding prolongs the effect of <b>α-agonists</b> in patients with <b>dark pigmented iris</b>.</li> <li>- Chloroquine binds to retinal pigment → ↓ visual acuity.</li> </ul>



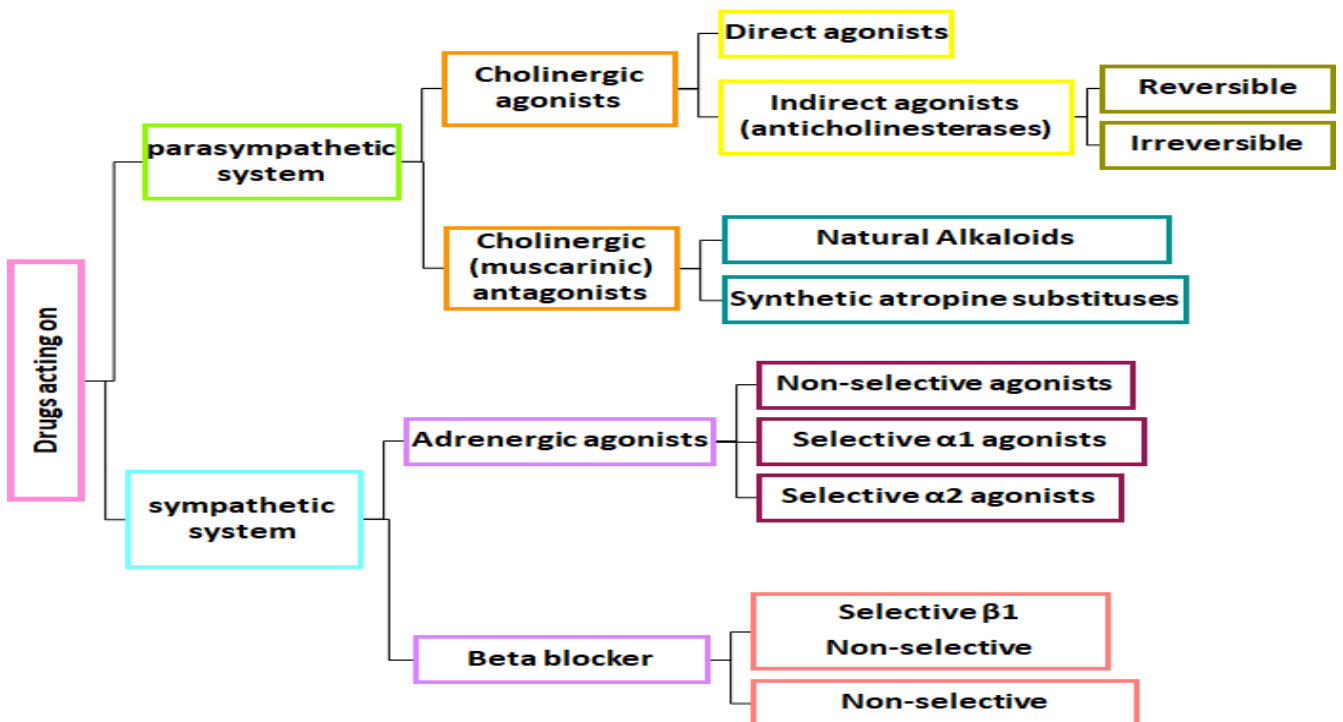
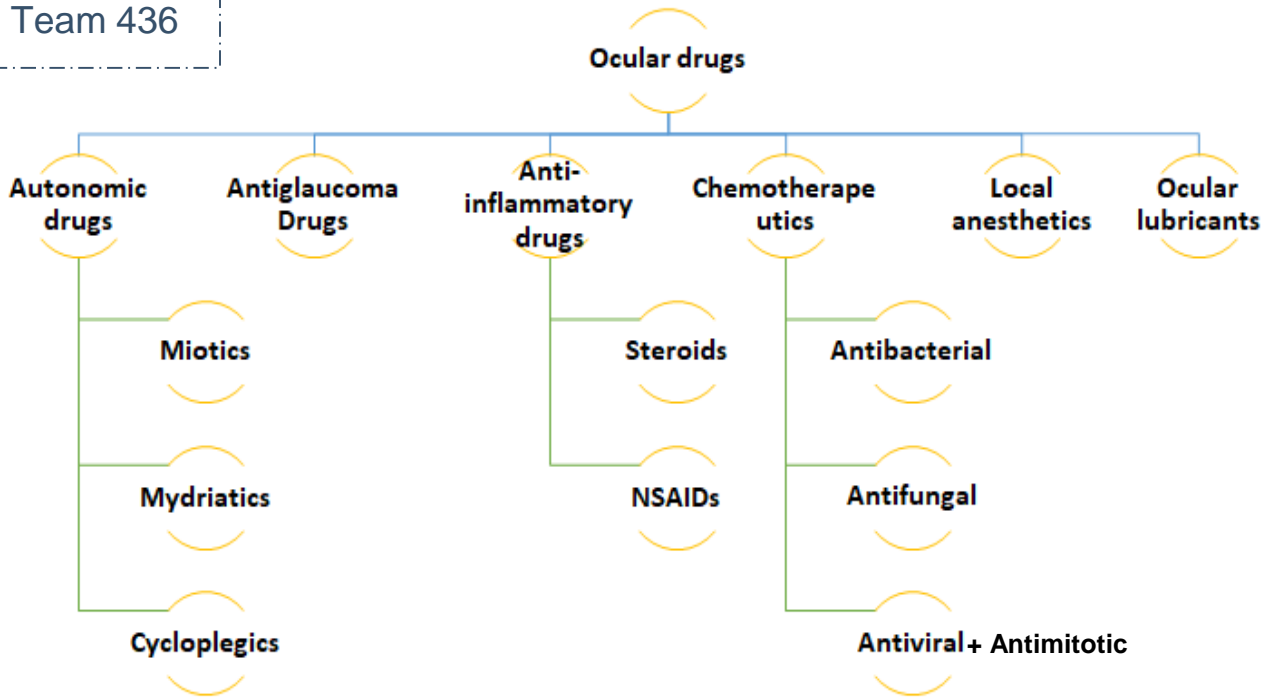
## Second- systemically:

### Oral Or I.V. :

- Factors that can control systemic drug penetration into ocular tissue are :
  - **lipid solubility of the drug:** more penetration with high lipid solubility.  
(High lipid soluble drug → high absorption → high distribution).
  - **Protein binding:** more effect with low protein binding (inverse proportion).
  - **Eye inflammation:** more penetration with ocular inflammation.  
(In case of inflammation (meningitis), it can affect the penetration ability of certain medications because it will affect the permeability even if the medication is polar)

# Overview

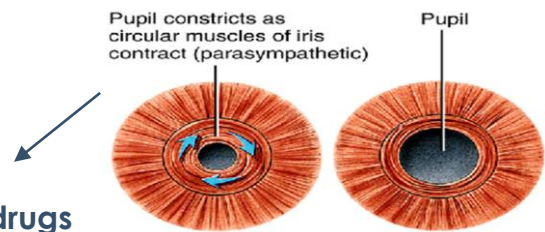
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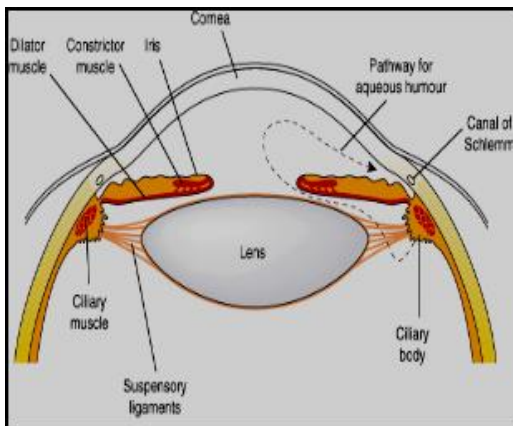
## Ocular actions of cholinergic(parasympathetic) drugs:

- 1- Contraction of the pupillary sphincter muscle (**miosis**)
- 2- Contraction of the ciliary muscle (**accommodation for near vision**).
- 3- Decrease in intraocular pressure **↓ IOP.**
- 4- increases aqueous outflow through the trabecular meshwork into canal of Schlemm by ciliary muscle contraction.
- 5- Increased lacrimation
- 6- Conjunctival Vasodilatation

### Miosis by parasympathetic drugs



## Aqueous production and drainage:




The aqueous humor is secreted by the epithelium of ciliary body. Produced by a combination of active transport of ions and ultrafiltration of interstitial fluid. The fluid flows over the surface of the lens, out through the pupil into the anterior chamber. Flows through (**Drainage by**) 1- the trabecular meshwork into Schlemm's canal 2- and uveoscleral drainage is collected in the scleral veins.

**(Decrease in IOP by parasympathetic drugs)**

**By using the drug the iris pulled away + the ciliary muscles contract >> angle of filtration (drainage) increased >> more drainage**

# Drugs acting on parasympathetic system

## Cholinergic agonists

Drug	Indirect agonists (anticholinesterases)				Direct agonists				
	Irreversible (phosphate ester)		reversible		Pilocarpine	Carbachol  0:23 min	Ach	Methacholine	
	Isoflurophate	Echothiophate	Physostigmine	Demecarium					
Indications	<b>Isoflurophate, Echothiophate, Physostigmine:</b> <ul style="list-style-type: none"> <li>Glaucoma</li> <li>Accommodative <b>esotropia</b> (نوع من الحول) → <b>Echothiophate</b>.</li> <li>In <b>lice</b> infestation of lashes → <b>Physostigmine</b>.</li> </ul>				<b>Open angle glaucoma</b> * The <b>drug of choice</b> in <b>acute</b> attack (closed or open glaucoma)		<b>Carbachol, Methacholine:</b> <ul style="list-style-type: none"> <li>Induction of <b>miosis</b> in surgery.</li> <li>Open angle glaucoma.</li> </ul> * <b>Carbachol</b> → causing pupillary contraction and a decrease in intraocular pressure.		<b>Specific uses</b>
	<ul style="list-style-type: none"> <li>Glaucoma (open &amp; closed angle).</li> <li>Counteract action of mydriatics.</li> <li>To break iris-lens adhesions. (<b>postoperative</b>)</li> <li>In accommodative esotropia (<b>Echothiophate</b>). (نوع من الحول)</li> </ul>						<b>General uses</b>		
ADRs	<ul style="list-style-type: none"> <li>Diminished vision (<b>myopia</b>).</li> <li>Headache.</li> </ul>						ocular		



# Drugs acting on parasympathetic system

## Cholinergic (muscarinic) antagonists

Drug	Synthetic <b>atropine</b> substitutes			Natural alkaloids	
	Tropicamide	Cyclopentolate	Homatropine	Scopolamine (Hyoscine)	Atropine
Duration of effect	6 hours	24 hours	1-3 days	3-7 days	7-10 days
	Short duration			Long duration	
M.O.A.	<ul style="list-style-type: none"> <li>• <b>Passive mydriasis</b> → due to <b>relaxation of circular muscles</b>. (passive = without any effect of sympathetic)</li> <li>• <b>Cycloplegia</b> (loss of <u>near</u> accommodation) → due to relaxation of <b>ciliary muscle</b>. (This effect is due to blocking of paraS only!)</li> <li>• Loss of <u>light reflex</u>.</li> <li>• <b>Increased IOP</b> → <b>glaucoma</b>. (especially angle closure glaucoma)</li> <li>• Decreased lacrimal secretion → <b>sandy eye</b>.</li> </ul>				
Indications	<ul style="list-style-type: none"> <li>• <b>To prevent adhesion in uveitis &amp; iritis</b>. → bc they are doing <b>mydriasis</b>.</li> <li>• Funduscopic examination of the eye.</li> <li>• Measurement of <b>refractive error</b>. → (myopia, hyperopia) problem with focusing of light on the retina due to the shape of the eye.</li> </ul>				
C.I.	<ul style="list-style-type: none"> <li>• <b>Glaucoma</b> (angle <b>closure</b> glaucoma) → Because there is no miosis → which makes the filtration easier → IOP may rise dangerously → acute attack of eye pain.</li> </ul>				

### Extra:

#### Active vs. passive mydriasis:

- Atropine (anticholinergic): **Blocking** muscarinic receptors → **relaxing circular muscles** → **Passive Mydriasis**
- Sympathetic stimulation: **activation** of a receptors in radial muscles → **contraction** → **Active mydriasis**

\*\* in the sympathetic system, activation of a receptors leads to smooth muscle contraction, and activation of  $\beta_2$  receptors leads to smooth muscle relaxation.

# Adrenergic agonists

Drug	<b>Selective <math>\alpha_2</math> agonists</b> <b>Apraclonidine</b> ابرا خفيف دم يقلل الضغط ودقات (القلب لكنه يسبب صداع) hypertention	<b>Selective <math>\alpha_1</math> agonists</b> <b>phenylephrine</b> (ابو فنيلة يرفع الضغط) vasopressin	<b>Non-selective agonists</b> ( $\alpha_1, \alpha_2, \beta_1, \beta_2$ ) <b>Dipivefrin</b> (pro-drug of epinephrin) <b>epinephrine</b>
M.O.A.	- ↓ production of aqueous humor. - ↑ uveoscleral outflow of aqueous humor. - Inhibits sympathetic working.	<b>Active mydriasis</b> due to contraction of radial muscles of the eye <b>(without cycloplegia)</b>	- ↓ aqueous humor production through vasoconstriction of ciliary body blood vessels. - Increase uveoscleral outflow of aqueous humor. - Mydriasis <b>(without cycloplegia)</b>
Uses	<ul style="list-style-type: none"> <li>• <b>Open</b> angle glaucoma treatment</li> <li>• <b>Prophylaxis</b> against IOP spiking after <b>glaucoma laser procedures</b>.</li> </ul>	<ul style="list-style-type: none"> <li>• Fundoscopic <b>examination</b> of the eye.</li> <li>• To prevent <b>adhesion</b> in uveitis &amp; iritis.</li> <li>• <b>Decongestant</b> in minor allergic hyperemia of eye.</li> </ul>	-Used locally as <b>eye drops</b> → to minimize the ADRs <b>in Open</b> angle glaucoma. Dipivefrin has Long duration of action the epinephrine - Fundusoscopic <b>examination</b> of the eye. -To prevent <b>adhesion</b> in uveitis & iritis - <b>Decongestant</b> in minor allergic hyperemia of eye
ADRs	<ul style="list-style-type: none"> <li>• Bradycardia.</li> <li>• Hypotension.</li> </ul>	<ul style="list-style-type: none"> <li>• May cause significant <b>increase in blood pressure</b>.</li> <li>• Rebound congestion.</li> </ul>	<ul style="list-style-type: none"> <li>• Headache.</li> <li>• Arrhythmia.</li> <li>• Increased blood pressure.</li> </ul>
C.I	----	in patients with <u>narrow angles</u> as they may precipitate <b>closed angle glaucoma</b>	

# β Blockers

Drug	Selective $\beta_1$ (cardio-selective) <b>betaxolol</b>	Non-selective	
		<b>carteolol</b>	<b>timolol</b>
MOA	Act on epithelium of ciliary body to ↓ production of aqueous humor.		
Route of administration	Given topically as <b>eye drops</b> . <div style="border: 1px dashed gray; padding: 5px; margin-left: 200px;"> <p><b>Mnemonics!!</b></p> <p>*<b>Carteolol</b>: Carrots are good for your eyes</p> <p>*<b>Timolol</b>: Takes a long time</p> <p>*<b>Betaxolol</b>: Selective <b>B1</b> Blockers</p> </div>		
Advantages	Can be used in patients with <b>hypertension</b> & <b>ischemic heart disease</b> .		
Uses	<b>Open angle glaucoma</b> . $\beta$ -adrenergic blocker <b>timolol</b> , are effective in treating <u>chronic</u> glaucoma but are <b>not</b> used for emergency lowering of intraocular pressure.		
ADRs	Ocular effects: Irritation.		

# Treatment of open angle glaucoma (chronic)



The main goal is to **decrease IOP** by:

**1- Decreasing** production of aqueous humor.

- Beta blockers
- Alpha-**2** agonists
- Carbonic anhydrase inhibitors

**2- Increasing** outflow of aqueous humor.

- Prostaglandins.
- Adrenergic agonists, nonspecific.
- Parasympathomimetics.

**Prostaglandins and Beta blockers are the most popular**

Drug	Prostaglandin analogues E.g. <b>latanoprost</b> , <b>travoprost</b>	Carbonic anhydrase inhibitors* E.g. <b>acetazolamide</b> (oral) <b>dorzolamide</b> (topical)
M.O.A.	↑uveoscleral aqueous outflow - <b>Latanoprost</b> is <b>preferred</b> due to lesser adverse effects. - They have <u>replaced</u> <b>beta blockers</b> . "Better than beta blockers because it has a long duration → use it once a day" They are used topically as <b>eye drops</b> & <b>once a day</b> .	- ↓ production of aqueous humor by <b>blocking carbonic anhydrase enzyme</b> required for <b>production of bicarbonate ions</b> → (transported to posterior chamber, carrying osmotic water flow).
Uses	<b>open angle glaucoma</b>	
ADRs	<ul style="list-style-type: none"> <li>• <b>Pigmentation of the iris</b> (heterochromia iridis)</li> </ul>	<ul style="list-style-type: none"> <li>• Myopia (Nearsightedness) , malaise, anorexia,</li> <li>• GI upset, headache. Metabolic acidosis, renal stone.</li> </ul>
C.I	<div style="border: 1px dashed black; padding: 5px; text-align: center;"> <p>Mnemonics!! <b>Prostaglandin analogues ADRs:</b> - "لا تأكل بروسند أكثر من مره باليوم" (Prost) - "Irise up with Big Broast (Iris pigmentation, Prostaglandin)"</p> </div>	<ul style="list-style-type: none"> <li>• <b>Sulfa allergy</b></li> <li>• <b>Pregnancy</b>, "Affects fetus"</li> <li>• <b>Digitalis</b> users.</li> </ul>

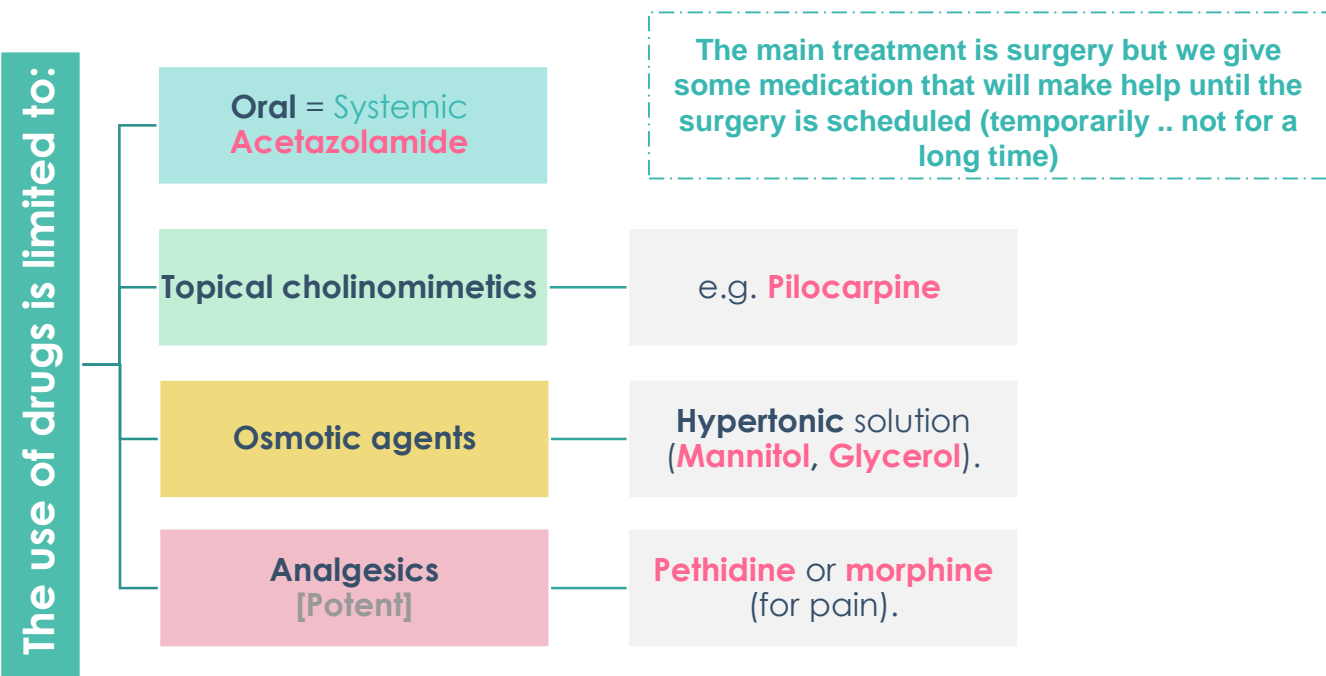
Mnemonics!!

Carbonic Anhydrase: (ADRs)

- "I can't see Any Cars (Carbonic Anhydrase) because I have Myopia"

# Treatment of narrow **closed** angle glaucoma (**acute**)

- **Acute, painful** increases of intraocular pressure due to **occlusion** of the outflow drainage pathway.
- The only way to treat it → Surgery, but before surgery we give him treatment.
- emergency situation that require treatment before surgery (**Iridectomy**)



Osmotic agents ( dehydrating agent ) → Systemic	
<b>MOA</b>	<ul style="list-style-type: none"> <li>- IV infusion of hypertonic solution (Mannitol, Glycerol).</li> <li>- Can <b>rapidly</b> ↓ IOP by ↓ vitreous volume prior to anterior surgical procedures.</li> <li>- <b>Glycerol 50% syrup, orally</b> (cause nausea, <b>hyperglycemia</b>).</li> <li>- <b>Mannitol 20% IV</b> (cause fluid overload and <b>not</b> used in <b>heart failure</b>).</li> </ul>
<b>Indications</b>	Used <u>only</u> in <b>acute situations</b> to temporarily reduce high IOP until more definitive treatments can be rendered. (short term management)
<b>ADRs</b>	- Diuresis, circulatory overload, pulmonary edema , heart failure, central nervous system effects <u>such as seizure, and cerebral hemorrhage</u> .

# Anti-inflammatory drugs

## Anti-inflammatory

corticosteroid

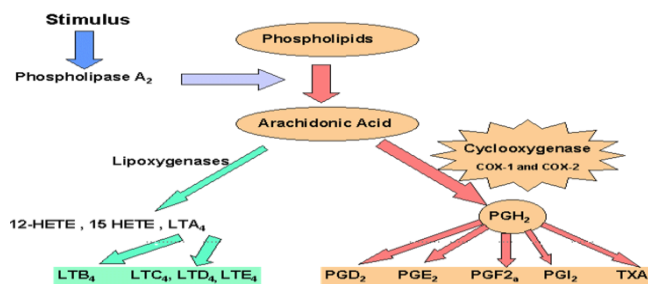
NSAID

Even if it's used topically  
will cause glaucoma

























## Corticosteroids

<b>MOA</b>	- Inhibition of <b>arachidonic acid</b> release from phospholipids by inhibiting <b>phospholipase A2</b>	
<b>Indications</b>	<b>Systemic</b> E.g. <b>prednisolone, cortisone</b>	<b>Topical</b> E.g. <b>prednisolone, dexamethasone, hydrocortisone</b>
	<b>Uses:</b> - posterior uveitis. - <b>optic neuritis.</b>	<b>Uses:</b> anterior uveitis, severe allergic conjunctivitis, scleritis, prevention and <b>suppression of corneal graft rejection.</b>
<b>ADRs</b>	- <b>Glaucoma</b> , cataract, increase IOP → especially if it used for a long time. - Skin atrophy. - Secondary infection. - Delayed wound healing. → (healing is slow bc it is an immune suppression)	


Figure 2 : Biosynthesis of eicosanoids



# Corticosteroids side effect

Decreased growth in children	 	Glaucoma	 	Centripetal distribution of body fat	 
Osteoporosis	 	Increased risk of infection	 	Hirsutism	 
Increased appetite	 	Emotional disturbances	 	Peptic ulcer	 
Hypertension	 	Peripheral edema	 	Hypokalemia	 

\* This pic is extra.

 9:09 min

NSAID			
Drug	Flurbiprofen	diclofenac	Ketorolac
MOA	COX (cyclo-oxygenase) - inhibitor		
Indications	Pre-operatively to <b>prevent miosis*</b> during <b>cataract surgery</b> . * Bc they inhibit prostaglandins which produce miosis without action of cholinergic.	<b>postoperative inflammation</b> , mild allergic conjunctivitis, mild uveitis.	<b>Cystoid macular edema</b> occurring <u>after</u> cataract surgery.
ADRs	<b>Stinging (irritation)</b> , sterile corneal melt & perforation.		

**Mnemonics!!**

Ketorolac: **after** cataract  
Flurbiprofen: **during** cataract

# Drugs causing corneal deposits

Amiodarone, Chloroquine

العمى: Optic neuropathy-تاج - "امى ملكة تاج لكنها مصابة بالعمى"

## Drugs causing corneal deposits

**Amiodarone,  
Chloroquine**

Pigmented deposits of cornea (**Deposition in eye lens >> optic neuropathy >> pigmentation**)

Retinopathy + Optic neuropathy<sup>1</sup>,

**digitalis  
cardiac failure drug**

ocular disturbances & **chromatopsia** (with overdose objects appear yellow)

**Phenothizines**

**Brown pigmentary** deposits in the cornea, conjunctiva & eyelid.

**Steroids**

**cataract formation**<sup>2</sup>, elevated IOP & glaucoma

**Ethambutol**<sup>5</sup>

**optic neuropathy** characterized by gradual Progressive central scotomas and vision loss.

**Sildenafil**

Causes a **bluish haze** & causing light sensitivity

**Ethambutol:**  
اثم بتول سبب لها "العمى"

Because it inhibits **retinal (PDE6)** as well as penile (PDE5) form of **phosphodiesterase**. → PDE6 controls the level of cyclic GMP in the retina → see **Bluish haze**

<sup>1</sup> **optic neuropathy:** mild decreased vision + visual field defects.

<sup>2</sup> [Click here to see a picture explains it.](#)

<sup>3</sup> TB medication.



# Summary

## Parasympathetic Drugs

	Cholinergic agonists				Cholinergic antagonists	
Function:	1- miosis -2- ↓ IOP. 3- Contraction of the ciliary muscle.. 4-↑ aqueous outflow. -5- ↑ lacrimation 6-Conjunctival Vasodilation				1-Passive Mydriasis 2-Cycloplegia - 3-Loss of light reflex. 4-↑ I.O.P # glaucoma. 5-↓Lacrimal secretion.	
Uses:	1- Glaucoma (open and closed angle) -2-Counteract action of mydriatics 3-To break iris-lens adhesions -4-in accommodative esotropia (ecothiophate)				1-Funduscopy examination 2-To prevent adhesion in uveitis & iritis 3-Measurement of refractive error (myopia, hyperopia).	
S/E	myopia, headache				-	
Types:	Direct		indirect		Natural alkaloids	Synthetic atropine
	-		Reversible	Irreversible	-	
	<ul style="list-style-type: none"> <li>●Carbachol</li> <li>●methacholine</li> </ul>	●pilocarpine	<ul style="list-style-type: none"> <li>●Physostigmine</li> <li>●demecarium</li> </ul>	<ul style="list-style-type: none"> <li>●Ecothiophate</li> <li>●Isoflurophate</li> </ul>	<ul style="list-style-type: none"> <li>●Atropine</li> <li>●Scopolamine (hyoscine)</li> </ul>	<ul style="list-style-type: none"> <li>● Homatropine</li> <li>● Cyclopentolate</li> <li>● Tropicamide</li> </ul>
Uses:	<ul style="list-style-type: none"> <li>● miosis in surgery</li> <li>●Open angle glaucoma</li> </ul>	-	Glaucoma, accommodative esotropia		-	

## Sympathetic Drugs

	Adrenergic agonist			β blockers	
Function:	1-Active mydriasis : α1 2-Relaxation of ciliary muscles: β2 3-Vasoconstriction of conjunctival blood vessels: α1 4- regulation of aqueous humour formation: α & β in the blood vessels of the ciliary processes				
Types:	Non-selective α1, α2, β1, β2	Selective α1	Selective agonists α2		Non-Selective blocker
	<ul style="list-style-type: none"> <li>● epinephrine</li> <li>●dipivefrin</li> </ul>	●phenylephrine	●apraclonidine		<ul style="list-style-type: none"> <li>● timolol</li> <li>●carteolol</li> </ul>
M.O.A:	↓ aqueous humor production ↑uveoscleral outflow	Active mydriasis (without cycloplegia)	↓production of aqueous humor ↑uveoscleral outflow of aqueous humor		Act on epithelium of ciliary body to decrease production of aqueous humor.
Uses:	eye drops, In open angle glaucoma	<ul style="list-style-type: none"> <li>●Funduscopy examination.</li> <li>●prevent adhesion in uveitis &amp; iritis.</li> </ul>	<ul style="list-style-type: none"> <li>●open glaucoma</li> <li>●prophylaxis against IOP</li> </ul>		open glaucoma + can be used in patients with hypertension
S/E:	<ul style="list-style-type: none"> <li>● headache</li> <li>● arrhythmia</li> <li>●elevated BP</li> </ul>	<ul style="list-style-type: none"> <li>●↑ in BP.</li> <li>●Rebound congestion</li> <li>● precipitation of acute angle closure glaucoma</li> </ul>	<ul style="list-style-type: none"> <li>●Bradycardia</li> <li>●hypotension</li> </ul>		●Ocular irritation

# Summary

## Treatment of open angle glaucoma (chronic):

### by decreasing IOP:

#### A-Decreasing production of aqueous humor:

- 1-Beta blockers
- 2-Alpha-2 agonists
- 3-Carbonic anhydrase inhibitors

#### B-Increasing outflow of aqueous humor:

- 1-Prostaglandins
- 2-Adrenergic agonists, nonspecific
- 3-Parasympathomimetics

Prostaglandins and  $\beta$  blockers are the most popular

## Treatment of narrow closed angle glaucoma (Acute angle glaucoma)

The use of drugs is limited to :

- Oral Acetazolamide**
- Topical cholinomimetics:** pilocarpine
- Osmotic agents:** Mannitol, Glycerol.
- Analgesics:**pethidine or morphine (for pain)

## Treatment of chronic open angle glaucoma

	Carbonic anhydrase inhibitors	Prostaglandin analogues
	Acetazolamide - dorzolamide	latanoprost - travoprost
<b>M.O.A</b>	↓ production of aqueous humor by blocking carbonic anhydrase enzyme required for production of bicarbonate ions	↑ uveoscleral aqueous outflow.
<b>S/E</b>	Myopia, malaise, anorexia, GI upset, headache Metabolic acidosis, renal stone	heterochromia iridis
<b>C.I</b>	Sulpha allergy - pregnancy	-

## Treatment of Acute angle glaucoma

### Osmotic agents

	Mannitol	Glycerol
<b>M.O.A</b>	Rapid lowering of IOP by decreasing vitreous volume	
<b>S/E</b>	Diuresis, circulatory overload, pulmonary edema and heart failure, central nervous system effects	

# Summary

## Ocular drugs

	Corticosteroids		NSAID		
<b>M.O.A</b>	inhibition of arachidonic acid by inhibiting phospholipase A2		inhibition of cyclo-oxygenase		
<b>Types:</b>	Topical	Systemic			
<b>Drugs:</b>	<ul style="list-style-type: none"> <li>●Prednisolone</li> <li>●Dexamethasone</li> <li>●hydrocortisone</li> </ul>	<ul style="list-style-type: none"> <li>●Prednisolone</li> <li>●cortisone</li> </ul>	Flurbiprofen	Diclofenac	Ketorolac
<b>Uses:</b>	<ul style="list-style-type: none"> <li>●anterior uveitis</li> <li>●severe allergic conjunctivitis</li> <li>●scleritis</li> </ul>	<ul style="list-style-type: none"> <li>●posterior uveitis</li> <li>●optic neuritis</li> </ul>	pre-operatively to prevent miosis	postoperatively, mild allergic conjunctivitis, mild uveitis	cystoid macular edema
<b>S/E</b>	Glaucoma, increase IOP, cataract		stinging		

## Drugs causing corneal deposits

Amiodarone & chloroquine	Ethambutol	Digitalis	Phenothiazines	Steroids	Sildenafil
optic neuropathy		ocular disturbances & <u>chromatopsia</u>	brown pigmentary deposits cornea, conjunctiva & eyelid	cataract formation, elevated IOP & glaucoma	bluish haze & light sensitivity
Pigmented deposits of the cornea					

# Questions

## MCQs

**1- Rate of absorption of a topical drug to the eye is determined by \_\_\_\_.**

- A- Dose.
- B- Size of molecule.
- C- Time of the drug staying in clu-de-sac.
- D- Polarity.

**2- chloroquine binds to retinal, which will result in?**

- A- Increase visual acuity.
- B- Decrease visual acuity.
- C- Loss of vision.
- D- Relaxation of pupillary muscles.

**3- \_\_\_\_\_ activates pro-drugs.**

- A- Chloroquine.
- B- Estrases.
- C- convertase.
- D- Isomerase.

**4- An ophthalmologist is going to perform a cataract surgery (which is related to the lens of the eye). What is the best route to administer acetylcholine?**

- A- Intracameral.
- B- subconjunctival.
- C- Intravitreal.
- D- retrobulbar.

**5- patient was given a drug orally, to treat glaucoma. What are the factors influencing this type of route administered?**

- A-Water solubility.
- B- low protein binding.
- C- ocular inflammation.
- D- B and C.

**6-patient is taking pilocarpine for treatment to open angle glaucoma. (1) which class does it belong to? (2) what is the mechanism of action?**

- 1/ A-parasympathomimetic. B-alpha blocker. C-NSAIDS. D-none
- 2/ A-Increase IOP. B-Decrease IOP. C-Decrease Aqueous Humor production. D-Increase lacrimation.

MCQs Answers:

- 1- C
- 2- A
- 3- B
- 4- A
- 5- D
- 6- A&B

# Questions

## MCQs

**7- increases uveoscleral outflow of aqueous humor, is mechanism of which of the following drug classes used in open angle glaucoma treatment?**

- A- Adrenergic agonist.
- B- parasympathomimetic.
- C- Cholinergic antagonist.
- D- Adrenergic antagonist.

**8- Acts on ciliary body specifically targeting carbonic anhydrase, to decrease production of aqueous humor.**

- A- Beta blockers.
- B- Alpha2 blockers.
- C- Carbonic anhydrase inhibitors.
- D- A and C

**9- what is the main goal in treating open angle glaucoma ?**

- A- Decrease IOP.
- B- Increase IOP.
- C- prevent aqueous humor outflow.
- D- A and C.

**10- A patient has open angle glaucoma. After a while of taking medication, she was not able to see while driving. What is the drug that could cause myopia as a side effect?**

- A- Carbachol.
- B- Apraclonidine.
- C- Timolol.
- D- Acetazolamide.

**11- A patient with heart failure history and using digitalis for it. Recently he was diagnosed with open angle glaucoma. Which of the following drug classes is contraindicated in treating open angle glaucoma?**

- A- Beta-blockers.
- B- Alpha-blockers.
- C- Carbonic anhydrase inhibitor.
- D- A and C

MCQs Answers:

- 7- A
- 8- C
- 9- A
- 10- D
- 11- C

# Questions

## MCQs

**12- A patient with open angle glaucoma, her doctor prescribed her latanoprost. What could latanoprost cause as side effect?**

- A- Headache.
- B- myopia.
- C- Change in corneal color.
- D- Change in Iris color.

**13- A patient using digitalis. what could overdose result in?**

- A- Glaucoma.
- B- colorless vision.
- C- Retinopathy.
- D- Optic neuropathy.

**14- Retinopathy is a result of toxic level of which medication?**

- A- Ethambutol.
- B- sildenafil.
- C- Chloroquine.
- D- A and C.

**15- physiatrist prescribed chlorpromazine (Phenothiazines) to a schizophrenic patient. at a toxic dose, what do you expect the patient may manifest?**

- A- Brown pigment deposit to cornea.
- B- Brown pigment deposit to conjunctiva.
- C- Brown pigment deposit to eyelid.
- D- A, B and C.

MCQs Answers:

- 12- D
- 13- B
- 14- D
- 15- D

## SAQ

**Q1/ How would you treat the eye for any underlying causes. What are the routes of administration. Give 2 examples each route. 2 disadvantages for each.**

A1/ Topical/ eye drops, injections and ointments.

Disadvantage: corneal & conjunctival toxicity - compliance

Systemic/ oral and IV.

**Q2/a patient is not able to read the journal, after measurement of refractive error procedure. the patient was administered with atropine. (1) Why? (2) why the patient can't read?**

1- atropine is an anti-cholinergic drug. One of its action is mydriasis (pupil dilatation), which is necessary for the procedure.

2- Atropine causes cycloplegia (loss of near sight accommodation) result of relaxation of ciliary muscles.

# Questions

## Cases

### Case1

A 45 years old patient, came to the clinic complaining for several months of Hazy vision, nausea, vomiting, sudden loss of vision, severe headache and eye pain. The doctor diagnosed him with glaucoma.

**Q1/ What type of glaucoma?**

open angle glaucoma (chronic).

**Q2/ Treatment goal(s)?**

1-decrease IOP by: decrease aqueous humor production-increase outflow of aqueous humor.

**Q3 / Mention 2 Drug classes for each mechanism of Action?**

1- decrease aqueous humor production:

Carbonic anhydrase. Side effects: (1) metabolic acidosis. (2) Anorexia.  
Beta Blockers.

2- Increase outflow of aqueous humor:

Prostaglandins. Side effects: (1) Iris color change.  
Adrenergic Agonists (non- specific).

### Case2

A 52 years old patient came to ER, with profuse tearing. His complains were Severe eye pain, nausea and vomiting, headache. Blurred vision and halos around light. The doctor on call diagnosed him with glaucoma and started treatment.

**Q1/ What type of glaucoma?**

Acute glaucoma (close angle glaucoma).

**Q2/ While preparing for surgery, what should you give the patient. mention 2 strategies, examples.**

Dehydrating agent: administration of hypertonic IV solution (mannitol, glycerol).

Oral Carbonic anhydrase: acetazolamide.

Topical cholinomimetics: Carbachol.

Analgesics: pethidine or morphine

## Team leaders:

Ghaida Saad Alsanad  
Mohammed Aggeel Bahatheg

## Team Members:

Dimah Alarafi  
Khalid Aldoseri  
Nouf Alotaibi  
Ghada Alqarni  
Omar Saleh Alsuhaibani  
Dawood Ismail  
Khulood Alwehaibi  
Hind Aloraier  
Ghada Emad Almuhanha  
Alanoud Abdulaziz AlmuFarrej  
Sarah Alkathiri  
Sara AlSultan

### References:

- Doctors' slides and notes.
- Pharmacology Team 435.

Special thank for team 435 ❤️



@Pharma4370



Pharm437@gmail.com