The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
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There are three:
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What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of _______ to the _______ cornea
--?
--?
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
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What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function? There are three:
--Facilitates diffusion of oxygen to the avascular cornea
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--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)
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Tear lake (strip; meniscus)
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Courtesy of the action of the upper lid (UL)
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The Tear Film

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What muscle is responsible for blinking? The Orbicularis oculi.

What is the basic arrangement of the fibers of the orbicularis? As multiple concentric bands encircling all or part of the orbital aperture.

The 'multiple bands' are organized into two basic portions—what are they? How are they defined?
--Orbital: The portion overlying orbital bone
--Palpebral: The portion overlying the lids
----Preseptal: The part overlying the orbital septum
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**What muscle is responsible for blinking?**

The orbicularis oculi

**During a blink**
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What muscle is responsible for blinking?
The orbicularis oculi

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The ‘multiple bands’ are organized into two basic portions—what are they?

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Preseptal: The part overlying the orbital septum

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The Tear Film

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During a blink
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several words

one word

During a blink
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There’s a fundamental distinction between the orbital and palpebral portions vis a vis blinking. What is it?

The palpebral portion is responsible for normal blinking, whereas the orbital portion comes into play only during effortful/voluntary eye closure.
The Tear Film

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The palpebral portion is subdivided into two parts—what are they?

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What muscle is responsible for blinking?
The orbicularis oculi

What is the basic arrangement of the fibers of the orbicularis?
As multiple concentric bands encircling all or part of the orbital aperture

The ‘multiple bands’ are organized into two basic portions—what are they?

How is each defined? The palpebral portion is subdivided into two parts—what are they?

--Orbital: The portion overlying the bones of the orbit
--Palpebral: The portion overlying the lids
    ----Preseptal
    ----Pretarsal
The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?

- Facilitates diffusion of oxygen to the avascular cornea
- Assists in clearing debris from the corneal surface
- Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')

The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it's needed?

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

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-- Orbital: The portion overlying the bones of the orbit
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---- Preseptal: ?
---- Pretarsal: ?

During a blink
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function? There are three:

--- Facilitates diffusion of oxygen to the avascular cornea
--- Assists in clearing debris from the corneal surface
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Where does the tear film reside? (The answer is not 'on the surface of the eye.') The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed? Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

What muscle is responsible for blinking? The orbicularis oculi

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The ‘multiple bands’ are organized into two basic portions—what are they? The palpebral portion is subdivided into two parts—what are they? How are they defined?

--- Orbital: The portion overlying the bones of the orbit
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---- Preseptal: The part overlying the orbital septum
---- Pretarsal: The part overlying the tarsal plates
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?

There are three:

--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')

The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure, (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

What muscle is responsible for blinking?
The orbicularis oculi

What is the basic arrangement of the fibers of the orbicularis?
As multiple concentric bands encircling all or part of the orbital aperture (aka 'multiple bands').

The ‘multiple bands’ are organized into two basic portions—what are they? How are they defined?

The palpebral portion is subdivided into two parts—what are they? How are they defined?

--Orbital: The portion overlying the bones of the orbit

--Palpebral: The portion overlying the lids

----Preseptal: The part overlying the orbital septum

----Pretarsal: The part overlying the tarsal plates
The Tear Film

Orbicularis oculi mm

Orbicularis palpebral portion:
- Preseptal
- Pretarsal
- Lateral palpebral raphe
- Orbicularis orbital portion
The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
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How does the tear volume get from the tear strip up onto the ocular surface where it’s needed? Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on the aqueous layer. If the lower lid (LL) isn’t really going up, what does it do?
The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves towards the nose.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
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How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on the aqueous layer. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
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Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on the aqueous layer.

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the puncta* for removal from the surface.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous layer, thereby pulling it across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do? It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

*Punctae? Puncti?
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
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Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)

So that’s how tear gets to the punctas, but how do they get into and through them?

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on the aqueous layer following along.

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas for removal from the surface.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
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Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)

So that’s how tear gets to the punctas, but how do they get into and through them?
Again, it’s all about the blink. Contracture of the orbicularis muscle compresses the lacrimal sac and canalicular system, thereby forcing tears within the system down the nasolacrimal duct. When the orbicularis relaxes, the lacrimal sac and canalicular system ‘re-inflate,’ thereby creating a negative pressure that sucks tears through the puncta, down the canaliculi, and into the sac.

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas for removal from the surface.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
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--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)

So that’s how tear gets to the punctas, but how do they get into and through them?

Again, it’s all about the blink. Contracture of the orbicularis muscle compresses the lacrimal sac and canalicular system, thereby forcing tears within the system down the nasolacrimal duct.

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas for removal from the surface.
The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)

So that’s how tear gets to the punctas, but how do they get into and through them?
Again, it’s all about the blink. Contracture of the orbicularis muscle compresses the lacrimal sac and canalicular system, thereby forcing tears within the system down the nasolacrimal duct. When the orbicularis relaxes, the lacrimal sac and canalicular system ‘re-inflate,’ thereby creating a negative pressure that sucks tears through the puncta, down the canaliculi, and into the sac.

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous layer. 

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas for removal from the surface.
The Tear Film

The Lacrimal Drainage System

Basic components of the nasolacrimal drainage system
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function? There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

In addition to moving down (UL) and horizontally (LL), the lids move in another direction of clinical significance—what is it?
Back toward the orbital apex
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus ) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the ‘interpalpebral fissure’ (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer

In addition to moving down (UL) and horizontally (LL), the lids move in another direction of clinical significance—what is it?
Back toward the orbital apex

What is the significance of this movement?

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not ‘on the surface of the eye.’)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down, the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary attraction force on theaqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the significance of this movement?
We’ll answer this shortly

In addition to moving down (UL) and horizontally (LL), the lids move in another direction of clinical significance—what is it?
Back toward the orbital apex

What is the significance of this movement?
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?

There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')

The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it's needed?

Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the 'interpalpebral fissure' (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?

It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

*Puncta: Small openings at the nasal end of the tear duct in the conjunctiva that drain tears into the nose.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it's needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the 'interpalpebral fissure' (the lower lid goes up a little, but not much). As it goes down, the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the typical blink rate (blinks/minute) when at rest?
About 10

What is the significance of this movement?
We'll answer this shortly
The Tear Film

What roles does the tear film (specifically, the preocular tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it's needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the typical blink rate (blinks/minute) when at rest?
About 10

There is a very common activity during which the blink rate doubles, to about 20/minute—what is it?
Conversation

There is a very common activity during which the blink rate halves, to about 5/minute—what is it?
Reading/near work
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?

There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye.')
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it's needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the interpalpebral fissure (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn't really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the typical blink rate (blinks/minute) when at rest?
About 10

There is a very common activity during which the blink rate doubles, to about 20/minute—what is it?
Conversation

What is the significance of this movement?
We'll answer this shortly
The Tear Film

What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye'.)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the 'interpalpebral fissure' (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the typical blink rate (blinks/minute) when at rest?
About 10

There is a very common activity during which the blink rate doubles, to about 20/minute—what is it?
Conversation

There is a very common activity during which the blink rate halves, to about 5/minute—what is it?

What is the significance of this movement?
We'll answer this shortly.
What roles does the tear film (specifically, the precorneal tear film) play in ocular health and function?
There are three:
--Facilitates diffusion of oxygen to the avascular cornea
--Assists in clearing debris from the corneal surface
--Provides a glassy-smooth refracting surface at the air-cornea interface (or more accurately, the air-tear film interface)

Where does the tear film reside? (The answer is not 'on the surface of the eye'.)
The bulk of tear volume is in the tear strip or lake (aka the tear meniscus) resting on the lower-lid margin.

How does the tear volume get from the tear strip up onto the ocular surface where it’s needed?
Courtesy of the action of the upper lid (UL). During a blink, the UL travels down across most of the extent of the ‘interpalpebral fissure’ (the lower lid goes up a little, but not much). As it goes down the UL wipes debris off the surface and into the lake. As it goes back up, the UL exerts a capillary-attraction force on the aqueous in the tear lake, thereby pulling it up across the ocular surface. (The oil layer follows along.)

If the lower lid (LL) isn’t really going up, what does it do?
It mainly moves horizontally towards the nose. In doing so, it pushes the tear lake (and the debris it contains) toward the punctas* for removal from the surface.

What is the typical blink rate (blinks/minute) when at rest?
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There is a very common activity during which the blink rate doubles, to about 20/minute—what is it?
Conversation

There is a very common activity during which the blink rate halves, to about 5/minute—what is it?
Reading/near work

What is the significance of this movement?
We'll answer this shortly
The tear film is comprised of basic components.
The tear film is comprised of three basic components.
The tear film is comprised of three basic components. What are they? --? --? --?
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin
The tear film is comprised of three basic components. What are they?

--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘[---] phase’), which in turn is covered by a lipid layer
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another? The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.
Two-phase model of the tear film. Schematic drawing of the structure of the tear film showing the outer lipid layer and the mucoaqueous layer.
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.
The tripartite model of the tear film
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect.
The tear film is comprised of three basic components. What are they?
--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another? The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

To be crystal clear: The current widely accepted conception is that of a 2-phase model in which a lipid layer overlies a mucocutaneous phase layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it’s incorrect.
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous' phase), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- ?
- ?
- ?

Which gland(s) produce the lipids constituting this layer?
The meibomian glands.
The tear film is comprised of three basic components. What are they? --Lipid --Aqueous --Mucin

How are the three components physically related to one another? The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucocorial phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they? --Inhibit tear film evaporation, thereby keeping it on the eye longer --?
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?

The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect.
The Tear Film

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?
--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film...two words...surface tension, thereby keeping it on the eye longer

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucocutaneous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucous, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it's incorrect.
The Tear Film

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?
--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film surface tension, thereby keeping it on the eye longer
----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake

Which gland(s) produce the lipids constituting this layer?
The meibomian glands

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.
The tear film is comprised of three basic components: Lipid, Aqueous, and Mucin.

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film surface tension, thereby keeping it on the eye longer
----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
--Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer? The meibomian glands.
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another? The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer

Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake.

- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer? The meibomian glands.
The Tear Film

The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
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The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?
The meibomian glands
The Tear Film

The tear film is comprised of three basic components. What are they?

--- Lipid
--- Aqueous
--- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucocutaneous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film surface tension, thereby keeping it on the eye longer
----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake.
--Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?
The meibomian glands.
The meibomian glands are embedded within the specific structure.
The meibomian glands are innervated primarily by the parasympathetic system.

There are up to twice as many meibomian glands in the upper lids.
The Tear Film

The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucocutaneous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucous, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ---- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?
The meibomian glands

The meibomian glands are embedded within the tarsal plates.

The meibomian glands are innervated primarily by the parasympathetic system.
The tear film is comprised of three basic components. What are they? 

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another? 

The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? 

The idea that the tear film is composed of three separate and distinct layers, each comprised of one component, i.e., separate mucin, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? 

While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they? 

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer? 

The meibomian glands are embedded within the tarsal plates.

The meibomian glands are innervated primarily by the parasympathetic system. Upper lid, lower lid, or both?
The Tear Film

The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?

The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is that it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ---- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The meibomian glands

The meibomian glands are embedded within the tarsal plates.

Upper lid, lower lid, or both?
Both
Meibomian glands
The Tear Film

The tear film is comprised of three basic components: Lipid, Aqueous, and Mucin. How are the three components physically related to one another?

- The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers, each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The meibomian glands. The meibomian glands are embedded within the tarsal plates.

The product of a meibomian gland is called meibum. There are up to twice as many meibomian glands in the upper lids. The meibomian glands are innervated primarily by the parasympathetic system.
The tear film is comprised of three basic components. What are they? 

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another? The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ---- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer? The meibomian glands

The meibomian glands are embedded within the tarsal plates.

The product of a meibomian gland is called meibum.
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucociliary phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ---- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?
The meibomian glands are embedded within the tarsal plates. The product of a meibomian gland is called meibum.

There are up to twice as many meibomian glands in the upper vs lower lids.
The Tear Film

### The tear film

The tear film is comprised of three basic components. What are they?

- **Lipid**
- **Aqueous**
- **Mucin**

How are the three components physically related to one another?

The aqueous and mucin components are intermixed into a single, gel-like layer (the ‘mucopurulent phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  - Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The **meibomian glands**

The meibomian glands are embedded within the **tarsal plates**

The product of a meibomian gland is called **meibum**

There are up to twice as many meibomian glands in the **upper lids**
The Tear Film

The tear film is comprised of three basic components: lipid, aqueous, and mucin.

How are the three components physically related to one another?

The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  ----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

- Meibomian glands

The meibomian glands are embedded within the tarsal plates.

The product of a meibomian gland is called meibum.

There are up to twice as many meibomian glands in the upper lids.

How many MGs are we talking about for each lid?

- Uppers: ?
- Lowers: ? (Looking for a range for each)
The tear film is comprised of three basic components. These are:

- **Lipid**
- **Aqueous**
- **Mucin**

How are the three components physically related to one another?

The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucous, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is it's incorrect.

---

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
  - Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The **meibomian glands**

The meibomian glands are embedded within the tarsal plates.

The product of a meibomian gland is called **meibum**.

There are up to twice as many meibomian glands in the upper lids.

How many MGs are we talking about for each lid?

- Uppers: 30-40
- Lowers: 20-30
The Tear Film

Upper lid

Lower lid

Meibomian glands
The Tear Film

The tear film is comprised of three basic components. What are they?

--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucociliary phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

The lipid component layer makes key contributions to the stability and effectiveness of the tear film—what are they?

--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film surface tension, thereby keeping it on the eye longer
-----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
--Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

meibomian glands

The meibomian glands are embedded within the tarsal plates.
The product of a meibomian gland is called meibum.
There are up to twice as many meibomian glands in the upper lids.
The meibomian glands are innervated primarily by the parasympathetic system.

sympathetic? parasympathetic? somatic?
The tear film is comprised of three basic components. What are they?
- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?
- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?
Meibomian glands

The meibomian glands are embedded within the tarsal plates.
The product of a meibomian gland is called meibum.
There are up to twice as many meibomian glands in the upper lids.
The meibomian glands are innervated primarily by the parasympathetic system.
The tear film is comprised of three basic components. What are they?--Lipid--Aqueous--Mucin

How are the three components physically related to one another? The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?
--Inhibit tear film evaporation, thereby keeping it on the eye longer
--Reduce tear film surface tension, thereby keeping it on the eye longer
----Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
--Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer? The meibomian glands.

The meibomian glands are embedded within the tarsal plates. The product of a meibomian gland is called meibum. There are up to twice as many meibomian glands in the upper lids. The meibomian glands are innervated primarily by the parasympathetic system.

What role does parasympathetic input play in meibum secretion? It is unclear at this time.
The Tear Film

The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the ‘mucoaqueous phase’), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it’s incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The meibomian glands

The meibomian glands are embedded within the tarsal plates. The product of a meibomian gland is called meibum. There are up to twice as many meibomian glands in the upper lids. The meibomian glands are innervated primarily by the parasympathetic system.

What role does parasympathetic input play in meibum secretion?
It is unclear at this time.
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?

The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is that it's incorrect.

The lipid component/layer makes key contributions to the stability and effectiveness of the tear film—what are they?

- Inhibit tear film evaporation, thereby keeping it on the eye longer
- Reduce tear film surface tension, thereby keeping it on the eye longer
- Without a lipid layer, surface tension (along with gravity) would pull the tear film down the eye to the lake
- Facilitate visual acuity by providing a smooth refracting surface

Which gland(s) produce the lipids constituting this layer?

The meibomian glands are embedded within the tarsal plates.

The product of a meibomian gland is called meibum.

There are up to twice as many meibomian glands in the upper lids.

The meibomian glands are innervated primarily by the parasympathetic system.

What role does parasympathetic input play in meibum secretion?

It is unclear at this time.

In addition to moving down (UL) and horizontally (LL), the lids move in another direction of clinical significance—what is it?

Back toward the orbital apex.

What is the significance of this movement?

We’ll answer this shortly.
The tear film is comprised of three basic components. What are they?

- Lipid
- Aqueous
- Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucocutaneous phase'), which in turn is covered by a lipid layer.

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The Tear Film

The tear film is comprised of three basic components:
- Lipid
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Back toward the orbital apex.

What is the significance of this movement?

We'll answer this shortly.
The Tear Film

1. What gland-type secretes the aqueous portion of the tear film?
   - Aqueous
   - Lipid
   - Mucin

2. How are the three components physically related to one another?
   The aqueous and mucin components are intermixed into a single, gel-like layer (the "mucocutaneous phase"), which in turn is covered by a lipid layer.

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The tear film is comprised of three basic components:

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What gland-type secretes the aqueous portion of the tear film? Lacrimal gland.

How many lacrimal glands are there (in each orbit)? Lots! But we think of them as being in one of two groups: 

--The main lacrimal gland
--The accessory lacrimal glands

Are they innervated? Yes, primarily by nerves of the parasympathetic system.
The Tear Film

The tear film is comprised of three basic components. What are they?
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What gland-type secretes the aqueous portion of the tear film?
Lacrimal gland

How many lacrimal glands are there (in each orbit)?
Lots! But we think of them as being in one of two groups:
-- Primary lacrimal gland
-- Accessory lacrimal glands

Are they innervated?
Yes, primarily by nerves of the parasympathetic system.
The tear film is comprised of three basic components. What are they?
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How are the three components physically related to one another?
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The tear film is comprised of three basic components: lipid, aqueous, and mucin. These components are physically related in that the aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

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The Tear Film

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Are they innervated?

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- The main lacrimal gland
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Are they innervated?

Yes, primarily by nerves of the parasympathetic system.

Where is the main lacrimal gland located?

The superotemporal orbit.

It’s divided into two lobes—what are they called?

Orbital and palpebral lobes.

What structure does the dividing?

The lateral horn of the levator aponeurosis.
The Tear Film

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What structure does the dividing?
The lateral horn of the levator aponeurosis.
The orbital lobe of the lacrimal gland (Lₒ) and the palpebral lobe of the lacrimal gland (Lₚ) are separated by the lateral horn of the levator aponeurosis (Ap)
(FYI: LPS = levator palpebralis superioris; Wh = Whitnall’s ligament)
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How many lacrimal glands are there (in each orbit)?
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There are two eponymous accessory glands—what are they?
  - Glands of Krauss, found in the fornices
  - Glands of Wolfring, found near the tarsal plates

Are these large, singular structures a la the main lac gland?
No, they are two sets of (much smaller) glands distributed throughout the orbit.

Which is more numerous—glands of Krauss, or of Wolfring?
There are about twice as many glands of Krauss as there are glands of Wolfring (i.e., 2/3 Krauss, 1/3 Wolfring).
The Tear Film

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What is the primary location for each? Glands of Krauss, found in the fornices, Glands of Wolfring.

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Lacrimal gland

How many lacrimal glands are there (in each orbit)?
Lots! But we think of them as being in one of two groups:
- The main lacrimal gland
- The accessory lacrimal glands

There are two eponymous accessory glands—what are they?
- Glands of Kraus, found in the fornices
- Glands of Wolfring, found near the tarsal plates

Are these large, singular structures a la the main lac gland?
No, they are two sets of much smaller glands distributed throughout the orbit.

Which is more numerous—glands of Krauss, or of Wolfring?
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The Tear Film

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What is the primary location for each?

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How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
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The Tear Film

What gland-type secretes the aqueous portion of the tear film?

---Lipid

---Aqueous

---Mucin

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Are they innervated?

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The Tear Film

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--- Solute
--- Proteins
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What is the primary role of electrolytes in the tear film?
To regulate tear-film osmolarity.

Why is tear-film osmolarity important?
Because of its associated osmotic-pressure gradient. The corneal epi cell membranes are freely permeable to water but not solutes; ie, they are semi-permeable. Recall the rule regarding semi-permeable membranes: Solvent follows solute. What this means is, if tear-film osmolarity gets too high, water within the epi cells will be pulled out of them via the osmotic gradient. This in turn severely stresses the epi cells, causing them to release inflammatory mediators that in turn disrupt the integrity of the ocular surface—and off we go down the DES highway.
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The Tear Film

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The Tear Film

In a sentence or two, what is osmolarity?

To regulate tear-film osmolarity
The Tear Film

In a sentence or two, what is osmolarity?
The concentration of solutes in a fluid—literally, the number of solute-particles in a given amount of solvent (fluid)
The Tear Film

The tear film is comprised of three basic components. What are they?

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How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

What gland-type secretes the aqueous portion of the tear film?
Lacrimal gland

How many lacrimal glands are there (in each orbit)?
 Lots! But we think of them as being in one of two groups:
--The main lacrimal gland
--The accessory lacrimal glands

Are they innervated?
Yes, primarily by nerves of the parasympathetic system.

There are two eponymous accessory glands—what are they?

What is the primary location for each?
--Glands of Krauss, found in the fornices
--Glands of Wolfring, found near the tarsal plates

Are these large, singular structures a la the main lac gland?
No, they are two sets of (much smaller) glands distributed throughout the orbit.

Which is more numerous—glands of Krauss, or of Wolfring?
There are about twice as many glands of Krauss as there are glands of Wolfring (ie, 2/3 Krauss, 1/3 Wolfring).

In addition to secreting its aqueous component, the lacrimal glands contribute important 'microconstituents' of the tear film. What are these?
--Electrolytes
--Solutes
--Proteins

Na⁺ and K⁺ figure prominently among the tear-film electrolytes. How do their concentrations in the tear film compare to that of serum?
Tear film Na⁺ is about equal to that of serum, whereas tear film K⁺ is about twice what it is in serum.

What is the primary role of electrolytes in the tear film?
To regulate tear-film osmolarity.

Why is tear-film osmolarity important?
Because of its associated osmotic-pressure gradient. The corneal epi cell membranes are freely permeable to water but not solutes; ie, they are semi-permeable. Recall the rule regarding semi-permeable membranes: solvent follows solute. What this means is, if tear-film osmolarity gets too high, water within the epi cells will be pulled out of them via the osmotic gradient. This in turn severely stresses the epi cells, causing them to release inflammatory mediators that in turn disrupt the integrity of the ocular surface—and off we go down the DES highway.

In a sentence or two, what is osmolarity?
The concentration of solutes in a fluid—literally, the number of solute-particles in a given amount of solvent (fluid). With regard to the tear film, it is expressed in

To regulate tear-film osmolarity.
The Tear Film

In a sentence or two, what is osmolarity?
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**The Tear Film**

1. **The Tear Film**

   The tear film is comprised of three basic components. What are they?
   - Lipid
   - Aqueous
   - Mucin

   How are the three components physically related to one another?
   The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

   As an aside: Briefly, what is the **tripartite model** of the tear film?
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2. **What gland-type secretes the aqueous portion of the tear film?**
   Lacrimal gland

3. **How many lacrimal glands are there (in each orbit)?**
   Lots! But we think of them as being in one of two groups:
   - Main lacrimal gland
   - Accessory lacrimal glands

4. **Are they innervated?**
   Yes, primarily by nerves of the parasympathetic system.

5. **There are two eponymous accessory glands—what are they?**
   - Glands of Krauss, found in the fornices
   - Glands of Wolfring, found near the tarsal plates

6. **Are these large, singular structures a la the main lac gland?**
   No, they are two sets of (much smaller) glands distributed throughout the orbit.

7. **Which is more numerous—glands of Krauss, or of Wolfring?**
   There are about twice as many glands of Krauss as there are glands of Wolfring (ie, 2/3 Krauss, 1/3 Wolfring)

8. **In addition to secreting its aqueous component, the lacrimal glands contribute important 'microconstituents' of the tear film. What are these?**
   - Electrolytes
   - Solutes
   - Proteins

9. **Na\(^+\) and K\(^+\) figure prominently among the tear-film electrolytes. How do their concentrations in the tear film compare to that of serum?**
   Tear film Na\(^+\) is about equal to that of serum, whereas tear film K\(^+\) is about twice what it is in serum.

10. **What is the primary role of electrolytes in the tear film?**
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11. **Why is tear-film osmolarity important?**
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    **Solvent follows solute**. What this means is, if tear-film osmolarity gets too high, water within the epi cells will be pulled out of them via the osmotic gradient. This in turn severely stresses the epi cells, causing them to release inflammatory mediators that in turn disrupt the integrity of the ocular surface—and off we go down the DES highway.

12. **In a sentence or two, what is osmolarity?**
    The concentration of solutes in a fluid—literally, the number of solute-particles in a given amount of solvent (fluid). With regard to the tear film, it is expressed in milliosmoles per liter (mOsm/L).

13. **What is normal tear osmolarity value? (It's a range.)**
    Normal tear osmolarity value is 296 ± 10 mOsm/L.

14. **In DES, do you expect tear osmolarity to be higher, or lower than normal?**
    Higher. Think of it this way: If the tear film is inadequate—if there's not enough fluid there—it means the solute-particles are dissolved in a smaller amount of fluid, which in turn means the concentration of the particles will be higher.

15. **What tear-osmolarity value is widely acknowledged as indicative of at least mild DES?**
    308 mOsm/L
The Tear Film

In a sentence or two, what is osmolarity?
The concentration of solutes in a fluid—literally, the number of solute-particles in a given amount of solvent (fluid). With regard to the tear film, it is expressed in milliosmoles per liter (mOsm/L).

What is normal tear osmolarity value? (It's a range.)
296 ± 10
The Tear Film

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What tear-osmolarity value is widely acknowledged as indicative of at least mild DES?
The Tear Film

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Higher. Think of it this way: If the tear film is inadequate—if there’s not enough fluid there—it means the solute-particles are dissolved in a smaller amount of fluid, which in turn means the concentration of the particles will be higher.

What tear-osmolarity value is widely acknowledged as indicative of at least mild DES?
308
The Tear Film

The tear film is comprised of three basic components. What are they?

- **Lipid**
- **Aqueous**
- **Mucin**

How are the three components physically related to one another?

The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?

The idea that the tear film is composed of three separate and distinct layers each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?

While once widely accepted, consensus now is it's incorrect.

What gland-type secretes the aqueous portion of the tear film?

- **Lacrimal gland**

How many lacrimal glands are there (in each orbit)?

Lots! But we think of them as being in one of two groups:

- **The main lacrimal gland**
- **The accessory lacrimal glands**

Are they innervated?

Yes, primarily by nerves of the parasympathetic system.

There are two eponymous accessory glands—what are they?

- **Glands of Krauss**, found in the fornices
- **Glands of Wolfring**, found near the tarsal plates

Are these large, singular structures a la the main lac gland?

No, they are two sets of (much smaller) glands distributed throughout the orbit.

Which is more numerous—glands of Krauss, or of Wolfring?

There are about twice as many glands of Krauss as there are glands of Wolfring (i.e., 2/3 Krauss, 1/3 Wolfring).

In addition to secreting its aqueous component, the lacrimal glands contribute important ‘microconstituents’ of the tear film. What are these?

- **Electrolytes**
- **Solute**
- **Proteins**

*Na*⁺ and *K*²⁺ figure prominently among the tear-film electrolytes. How do their concentrations in the tear film compare to that of serum?

- Tear film *Na*⁺ is about equal to that of serum, whereas tear film *K*²⁺ is about twice what it is in serum.

What is the primary role of electrolytes in the tear film?

To regulate tear-film osmolarity.

Why is tear-film osmolarity important?

Next Q
The Tear Film

What gland-type secretes the aqueous portion of the tear film?
--Lipid
--Aqueous
--Mucin

The aqueous portion of the tear film is secreted by the lacrimal gland.

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
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What gland-type secretes the aqueous portion of the tear film?
--Lipid
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The lacrimal gland secretes the aqueous portion of the tear film.

How many lacrimal glands are there (in each orbit)?
Lots! But we think of them as being in one of two groups:
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Electrolytes
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Tear film $Na^+$ is about equal to that of serum, whereas tear film $K^{2+}$ is about twice what it is in serum.

What is the primary role of electrolytes in the tear film?
To regulate tear-film osmolarity.

Why is tear-film osmolarity important?
Because of its associated gradient.
The Tear Film

The tear film is comprised of three basic components. What are they?

- Lipid
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How are the three components physically related to one another?
The aqueous and mucin components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

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Why is tear-film osmolarity important?
Because of its associated osmotic-pressure gradient. The corneal epi cell membranes are freely permeable to water but not solutes; i.e., they are semi-permeable. Recall the rule regarding semi-permeable membranes: 

three words
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Are they innervated?
Yes, primarily by nerves of the parasympathetic system.

What are the main solutes in the tear film?
--Electrolytes
--Solute
--Proteins

In addition to secreting its aqueous component, the lacrimal glands contribute important 'microconstituents' of the tear film. What are these?
The usual suspects: Glucose, lactate, the amino acids, etc.

What is the primary location for each?
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There are about twice as many glands of Krauss as there are glands of Wolfring (ie, 2/3 Krauss, 1/3 Wolfring).
The Tear Film

The tear film is comprised of three basic components. What are they?

--Lipid
--Aqueous
--Mucin

How are the three components physically related to one another?
The aqueous and mucus components are intermixed into a single, gel-like layer (the 'mucoaqueous phase'), which in turn is covered by a lipid layer.

As an aside: Briefly, what is the tripartite model of the tear film?
The idea that the tear film is composed of three separate and distinct layers, each comprised of one component, i.e., separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it?
While once widely accepted, consensus now is it's incorrect.

What gland-type secretes the aqueous portion of the tear film?
Lacrimal gland

How many lacrimal glands are there (in each orbit)?
Lots! But we think of them as being in one of two groups:
--The main lacrimal gland
--The accessory lacrimal glands

Are they innervated?
Yes, primarily by nerves of the parasympathetic system.

There are two eponymous accessory glands—what are they?
Glands of Krauss, found in the fornices
Glands of Wolfring, found near the tarsal plates

Are these large, singular structures a la the main lac gland?
No, they are two sets of (much smaller) glands distributed throughout the orbit.

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In addition to secreting its aqueous component, the lacrimal glands contribute important ‘microconstituents’ of the tear film. What are these?

--Electrolytes
--Proteins
--Sugars

What are the main solutes in the tear film?
The usual suspects: Glucose, lactate, the amino acids, etc.
The Tear Film

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What are the main solutes in the tear film?
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What is the relationship between solute concentrations in the tear film and their respective concentrations in serum?
They are roughly equivalent.
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What are the main solutes in the tear film?
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What is the primary protein on the tear film?
Immunoglobulin, specifically IgA

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The Tear Film

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What is the chief function of the mucin component of the mucooaqueous layer?

- Facilitating surface wetting by transforming the epithelial surface from a hydrophobic to a hydrophilic state.

There are two types of mucin present in the tear film and on the ocular surface—what are they?

- Secreted mucins
- Membrane-bound* mucins

Which are found in the mucooaqueous layer/gel?

Secreted

Which cells are the chief producers of the secreted mucins?

Goblet cells located in the conjunctival epithelium.

The 'membrane bound' mucins—to which membrane(s), i.e., what cell types and locations, are they bound?

The epithelia of the cornea and conjunctiva.
The Tear Film

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*aka membrane-, membrane-spanning, membrane-anchored, and membrane-tethered.
The Tear Film

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**Mucin**

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The tear film is comprised of three basic components: lipid, aqueous, and mucin.

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As an aside: Briefly, what is the tripartite model of the tear film? The idea that the tear film is composed of three separate and distinct layers each comprised of one component, ie, separate mucus, aqueous, and lipid layers.

There is a problem with the tripartite model—what is it? While once widely accepted, consensus now is it's incorrect.

What is the chief function of the mucin component of the mucoaqueous layer? Facilitating surface wetting by transforming the epithelial surface from a hydrophobic to a hydrophilic state.

There are two types of mucin present in the tear film and on the ocular surface—what are they? --Secreted mucins --Membrane-bound* mucins

Which are found in the mucoaqueous layer/gel? Secreted

Which cells are the chief producers of the secreted mucins? Goblet cells located in the conjunctival epithelium

The 'membrane bound' mucins—to which membrane(s), ie, what cell types and locations, are they bound? The *aka membrane-spanning, membrane-anchored, and membrane-tethered
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--Aqueous

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'Transforming the epithelial surface from hydrophobic to hydrophilic'—why is this important?

Think about the ultrastructure of the membranous surface of K and conjunctival epithelial cells. The cell membranes have all sorts of phospholipids, glycolipids, etc, sticking up out of them. Because of their lipid nature, these molecules are highly hydrophobic—and thus the 'naked' ocular surface would be as well. There's no way a solution consisting solely of water could coat such a surface—it would simply bead up and fall off.

So how is the ocular surface to be kept moist? As always, nature finds a way. First, the ocular surface isn't 'naked;' rather, it is coated by a filamentous gel-like structure called the glycocalyx. Glycocalyces are common throughout nature (eg, bacterial capsules are a glycocalyx) and on multiple cell lines in humans. They serve many purposes related to cell-cell recognition and communication, host defense, etc. In ocular-surface epithelial cells, the membrane-bound mucins constitute a sizable component of the glycocalyx. The ability of the tear film to coat the ocular surface is greatly facilitated by interactions between the membrane-bound mucins of the glycocalyx and the mucoaqueous-layer 'bound' secreted mucins.
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