FRCOphth Part 1:
400 SBAs and CRQs

SECOND EDITION

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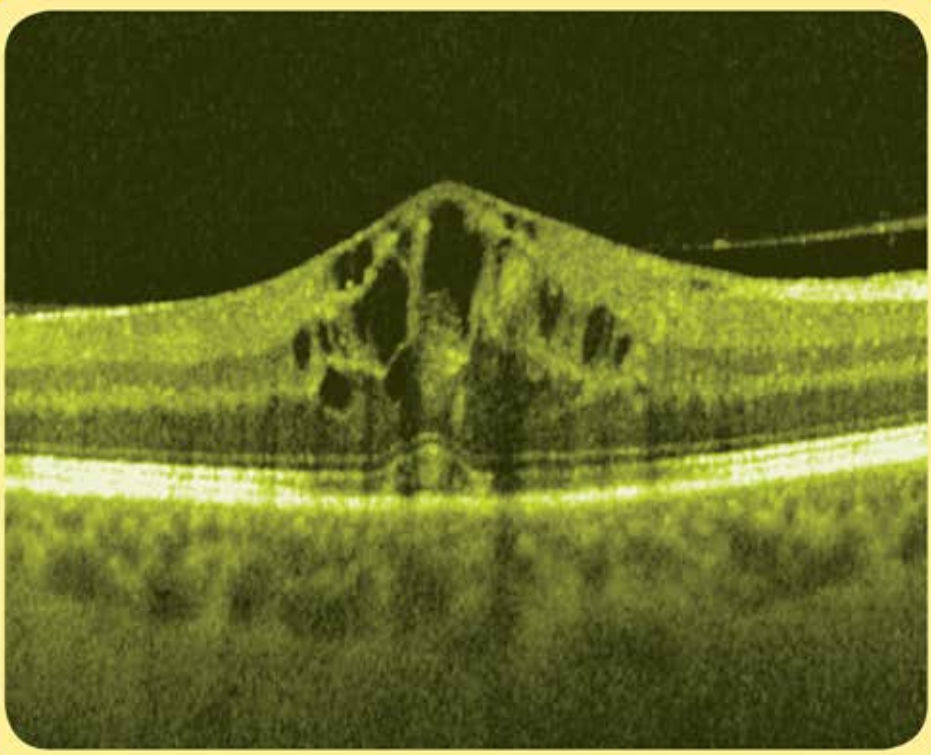

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Chapter 3

Exam Paper 3: Unstructured Mock Exam

Questions: SBAs

120 SBAs to be answered in 3 hours

For each question, please select the single best answer.

1. From which embryological cell population does the trabecular meshwork originate?

A Mesoderm
B Neural crest mesenchyme
C Neuroectoderm
D Surface ectoderm

2. An image produced by a concave mirror is real, inverted, enlarged and lies outside the centre of curvature. Where does the object lie?

A At the principal focus
B Between the centre of curvature and the principal focus
C Between the principal focus and the mirror
D Outside the centre of curvature

3. Which of the following antibiotics is least effective against Gram negative organisms?

A Amoxicillin
B Cefuroxime
C Metronidazole
D Vancomycin

4. Which of the following terms best describes a substance which only allows the transmission of light in an incident plane aligned with its structure, by absorbing other light waves?

A Birefringent
B Dichroic

C Mirrored
D Scattering

5. How far posterior to the limbus does the lateral rectus insert?

A 5.5 mm
B 6.5 mm
C 6.9 mm
D 7.7 mm

6. In which phase of clinical trial is dosing typically established?

A I
B II
C III
D IV

7. Which anatomical position is marked by the grey line?

A Anterior border of the lash line
B Anterior border of the orbicularis oculi
C Anterior border of the tarsal conjunctiva
D Anterior border of the tarsal plate

8. What is the predominant form of collagen in the matrix of the sclera?

A Type I
B Type II
C Type V
D Type VI

9. Which of the following is the most likely corneal endothelial cell density of a healthy 40-year-old human?

A 500 cells/mm^2
B 1,500 cells/mm^2
C 2,500 cells/mm^2
D 4,000 cells/mm^2

10. Which layer of the choroid lies furthest from the retina?

A Bruch's membrane
B Choriocapillaris
C Haller's layer
D Sattler's layer

11. What is the volume of the vitreous humour of an emmetropic adult?

A 3 mL
B 4 mL
C 5 mL
D 6 mL

12. Which of the following statements about skull osteology is true?

A The coronal suture joins the frontal and temporal bones
B The lambdoid suture lies above the pterion
C The posterior fontanelle closes before the anterior fontanelle
D The superciliary ridges are larger in females than males

13. Which one of the following statements about the Geneva lens measure is true?

A It is calibrated for the refractive index of crown glass
B It is possible to deduce the total power of a thin lens by measuring both surface powers and calculating the difference between them
C It uses three spring-loaded pins to measure the surface curvature of a lens
D When placed on a convex surface the central pin is extended relative to the peripheral pins

14. Which of the following statements about corneal innervation is false?

A Fewer than 100 main stromal nerve bundles enter the cornea at the limbus
B The inferior cornea is sometimes innervated by V2
C The mid-stromal plexus is densest in the central cornea
D Unmyelinated nerve fibres pierce Bowman's membrane to form the sub-basal plexus

15. What magnitude of accommodation will be required for a hypermetropic patient with a +2 dioptre prescription to read unaided at 20 cm?

A 3 dioptres
B 5 dioptres
C 7 dioptres
D 10 dioptres

16. Which of the following statements about the trabecular meshwork is false?

A Contraction of the ciliary muscle reduces resistance to aqueous outflow across the trabecular meshwork
B The cells of the juxtacanalicular meshwork are surrounded by an extracellular matrix
C The corneoscleral meshwork has a lamellar structure
D The uveal meshwork provides the greatest degree of resistance to aqueous humour outflow

17. Which of the following best describes the principal component of the lens zonules?

A Fibrillin
B Glycerol
C Lens epithelial cells
D Type IV collagen

18. Which of the following most accurately describes conjunctival microscopic anatomy?

A Most of the lymphoid tissue is located in the conjunctival epithelium
B The epithelium is stratified squamous in the palpebral and limbal portions
C The stroma in the palpebral conjunctiva is attached to Tenon's capsule
D Type V collagen is the main constituent of the epithelial basement membrane

19. Which of the following is not a typical route of toxoplasma infection?

A Contaminated drinking water
B Dog faeces
C Transplacental
D Undercooked meat

20. A 60-year-old man waiting for his diabetic eye clinic appointment develops chest pain. The electrocardiogram (ECG) shows ST elevation in leads V1–V4. Which coronary artery is likely to be blocked?

A Circumflex artery
B Left anterior descending artery
C Right coronary artery
D Right marginal artery

21. Regarding the optic nerve, which of these statements is incorrect?

A Axons arise from the retinal ganglion cells and synapse in the lateral geniculate body
B Myelin sheaths are formed from oligodendrocytes rather than Schwann cells
C There are approximately 3.7 million axons in the optic nerve
D The total length of the optic nerve is 4–5 cm

22. Regarding the primary visual cortex, which of the following is incorrect?

A Layer IV receives the optic radiations
B Layers V and VI project to the secondary visual cortex
C Macular function is represented posteriorly
D The contralateral upper visual field is represented below the calcarine sulcus

23. Which of the following are found in higher concentrations in the lens than in aqueous?

A Glucose and potassium
B Potassium and amino acids
C Sodium and chloride
D Water and glutathione

24. Which one of the following biochemical changes in the lens is not associated with cataract formation?

A Increased glutathione levels
B Increase in insoluble lens components
C Loss of αA crystallin and γS crystallin
D Protein cross-linking and aggregation

25. Regarding noradrenaline (norepinephrine), which of the following statements is false?

A It is a hormone
B It is a neurotransmitter
C It is metabolised by monoamine oxidase
D It is synthesised by catechol-O-methyltransferase

26. What is the degree of image magnification when viewing the fundus of a patient with 10 dioptres of myopia with a direct ophthalmoscope?

A × 12.5
B × 15
C × 17.5
D × 20

27. Which of the following best describes the lens epithelium?

A A simple cuboidal epithelium covering the anterior lens surface
B A simple cuboidal epithelium covering the posterior lens surface
C A stratified cuboidal epithelium covering the anterior lens surface
D A stratified cuboidal epithelium covering the posterior lens surface

28. Which of the following statements about retinal glucose metabolism is true?

A 50% of glucose utilisation in the retina is by the photoreceptors
B A high rate of aerobic respiration and a low rate of lactic acid production is characteristic
C Glucose uptake in the retina is independent of insulin levels
D The retina has a higher rate of aerobic glucose consumption than any tissue other than the liver

29. Which of the following best describes the basis of the dark current?

A An influx of potassium ions maintains a relative depolarisation of the photoreceptor

B An influx of potassium ions maintains a relative hyperpolarisation of the photoreceptor

C An influx of sodium ions maintains a relative depolarisation of the photoreceptor

D An influx of sodium ions maintains a relative hyperpolarisation of the photoreceptor

30. Which of these contributes to the blood–aqueous barrier?

A Capillaries in the ciliary processes

B Desmosomes in the pigmented ciliary epithelium

C Fenestrations in the iris capillaries

D Tight junctions in non-pigmented ciliary epithelium

31. Regarding the synthesis of melanin, select the incorrect statement.

A Deficiency of tyrosinase leads to albinism

B Melanin and adrenaline are derived from the same amino acid

C Melanin can be synthesised from phenylalanine

D Melanocytes are unable to produce melanin in vitiligo

32. Apoptosis can be triggered by internal or external factors. Which of these is not a trigger for programmed cell death?

A BAX

B BCL-2

C Fas ligand

D TNF-α

33. What is the approximate rate of cerebrospinal fluid production?

A 50 mL/day

B 150 mL/day

C 300 mL/day

D 550 mL/day

34. Which of the following is not an ocular effect of ionising radiation?

A Ablation of the retinal pigment epithelium and outer retina

B Cicatricial conjunctivitis

C Dry eyes

D Radiation retinopathy

Answers: SBAs

1. B Neural crest mesenchyme

The lens vesicle (an invagination of surface ectoderm) separates in week 5. The surface ectoderm reconnects anteriorly to the forming lens, and will become the corneal epithelium. Neural crest-derived mesenchymal cells then migrate in waves into the space that will later become the anterior chamber. The trabecular meshwork, corneal endothelium, corneal stroma and the iris stroma all arise from these cells.

2. B Between the centre of curvature and the principal focus

A real, inverted and enlarged image from a concave mirror arises when an object is between the centre of curvature and the principal focus. It is always worth drawing the ray diagram for these questions. One ray runs from the top of the object parallel to the principal axis, and is reflected through the principal focus. The other runs from the top of the object through the centre of curvature and will therefore hit the mirror at 90° to the surface, and be reflected along the same path. The image is formed where these two rays intersect (see Figure 1.1, page 50). Note that because the question gives information on where the image lies it is possible to draw the diagram in reverse, starting with the image and tracing back through the centre of curvature and principal focus.

3. D Vancomycin

Vancomycin (a glycopeptide antibiotic) is ineffective against Gram negative bacteria as it cannot penetrate their outer membrane. Cefuroxime is a second generation cephalosporin and has broad coverage of both Gram positive and Gram negative bacteria. Amoxicillin is an aminopenicillin and has activity against some Gram negative (in addition to multiple Gram positive) organisms. Metronidazole, a nitroimidazole, is active against most Gram negative and Gram positive anaerobes as well as many protozoans.

4. B Dichroic

Polarised light consists of light waves which are all orientated in the same plane. Polarisation can be achieved by different methods, such as selective absorption (e.g. in dichroism), reflection, scattering or the use of birefringent materials. Polarisation results in a reduction in intensity, but spectral composition is unaffected.

The property described in the question is dichroism. A dichroic substance only allows the transmission of light in an incident plane aligned with its structure by absorbing light waves in other planes.

There are naturally occurring crystalline dichroic substances, and manufactured ones, the best known being polaroid. Polaroid was originally composed of iodoquinine crystals embedded in plastic, although several variants have been developed.

5. C 6.9 mm

The origin of the four rectus muscles is the common tendinous ring or annulus of Zinn. Their insertions onto the sclera are measured in millimetres posterior to the limbus (**Table 3.1**). The closest to the limbus is the medial rectus, followed by inferior, lateral and then superior rectus. The medial rectus has the shortest tendon; the lateral rectus has the longest. The lateral rectus has a small second head arising from the orbital surface of the greater wing of sphenoid (lateral to the annulus of Zinn).

Table 3.1 Insertions of rectus muscles

Muscle	Insertion (mm from limbus)
Medial rectus	5.5
Inferior rectus	6.5
Lateral rectus	6.9
Superior rectus	7.7

6. B II

The different phases of clinical trials are outlined in **Table 3.2**. These are the phases of studies in humans and do not encompass all the previous laboratory and animal testing that a potential drug undergoes before entering clinical trials. Note that phase 0 trials and phase IV trials do not always occur.

Table 3.2 Phases of clinical trials

Clinical trial phase	Principal aim	Subjects
0	Human microdosing studies to establish safety	Healthy volunteers or target group of patients; usually <20 subjects
I	Assess principally safety and side effects, but also tolerability, pharmacokinetics and pharmacodynamics	Healthy volunteers or target group of patients; usually <100
II	Phase IIA: establish dosing Phase IIB: establish efficacy	Target group of patients; usually <300
III	Determine effectiveness, in particular effectiveness versus current gold standard; usually randomised clinical trials	Target group of patients; typically 1,000–3,000
IV	Postmarketing surveillance to detect side effects; further studies to continue to assess effectiveness (e.g. in different populations)	Target group; thousands of patients

7. D Anterior border of the tarsal plate

The grey line is a key landmark for a number of surgical procedures involving the eyelid and corresponds histologically to a superficial portion of the pretarsal orbicularis oculi (known as the muscle of Riolan), which marks the anterior border of the tarsal plate. The skin/conjunctival transition zone lies posterior to this, at the level of the Meibomian gland openings.

8. A Type I

The matrix of the sclera is predominantly composed of type I collagen. A number of other collagen types have been detected in the sclera in smaller quantities (including types III, IV, V, VI, VIII, XII and XIII). Interestingly the corneal stroma is also principally composed of type I collagen, but the laminar construction is highly regular, as opposed to the sclera which has an irregular arrangement of collagen and elastic fibres.

9. C 2,500 cells/mm^2

Corneal endothelial cell density in a healthy adult is normally approximately 2,500 cells/mm^2. 3,000–4,000 cells/mm^2 may be seen in a child's cornea, and in old age this usually falls to around 2,000 cells/mm^2. Pathological conditions, such as Fuchs' endothelial dystrophy, and iatrogenic causes, such as cataract surgery, may lower the endothelial cell count further and can lead to corneal decompensation.

10. C Haller's layer

The choroid is usually described in terms of four layers, listed below (**Table 3.3**) from the outermost (and therefore furthest from the retina) to the innermost. Some sources include the suprachoroid in this list: this transition zone lies outside Haller's layer.

Table 3.3 Layers of the choroid

Layer	Features
Haller's layer	Larger calibre arteries and veins
Sattler's layer	Intermediate calibre arterioles and venules
Choriocapillaris	Dense bed of fenestrated capillaries Only extends to the ora serrata anteriorly
Bruch's membrane	Acellular connective tissue layer Further subdivided into 5 layers (see page 36, question 15)

11. B 4 mL

The vitreous humour of an emmetropic adult is approximately 4 mL and therefore the vitreous accounts for approximately two-thirds of the total volume of the eye. The vitreous is approximately 99% water and therefore its mass in grams is approximately equal to its volume in mL.

12. C The posterior fontanelle closes before the anterior fontanelle

The posterior fontanelle is the first to close and usually closes 2–3 months after birth, whereas the anterior fontanelle closes last of all fontanelles at between 12 and 36 months.

The coronal suture joins the frontal and parietal bones. The lambdoid suture is the posterior suture joining the occipital and parietal bones. Its anterior ends form part of the asterion.

The superciliary ridges are larger in males than females (in some females they are absent altogether). This difference develops through puberty.

13. A It is calibrated for the refractive index of crown glass

The Geneva lens measure is calibrated for crown glass and gives a direct reading in dioptres. The power of lenses of other materials may be calculated if the refractive index is known. The total power of a thin lens is equal to the sum of both surface powers. There are three pins on a Geneva lens measure, but only the central pin is spring-loaded. The peripheral pins are fixed, and the reading is based on the position of the mobile central pin relative to the fixed peripheral pins. When placed on a convex surface the central pin is retracted relative to the peripheral pins (it is extended when placed on a concave surface).

14. C The mid-stromal plexus is densest in the central cornea

The cornea is principally innervated by nerves from V1 via the long ciliary nerves. In a small number of individuals there is some innervation of the inferior cornea from branches of V2.

Some 50–90 main stromal nerve fibres enter the cornea at the limbus in a radial direction. Perineurium and myelin sheaths are lost from these nerves near the limbus to preserve corneal clarity. They travel in the anterior half of the stroma, branching to form a mid-stromal nerve plexus. This is densest in the peripheral cornea and decreases in both density and complexity towards the central cornea.

Most mid-stromal nerve fibres pass anteriorly within the stroma and form a subepithelial plexus below Bowman's membrane. Nerves arising from this plexus pierce Bowman's membrane to pass anteriorly and form a plexus below the basal aspect of the corneal epithelium. From this sub-basal plexus, the sensory nerve endings arise to supply the corneal surface (there are more sensory nerve endings per unit area than anywhere else in the body).

15. C 7 dioptres

The accommodation required by an emmetropic patient to read unaided at a given distance is equal to the reciprocal of the distance in metres. In this case therefore the accommodative power required for an emmetropic patient would be 1/0.2, i.e. 5 dioptres. However, a patient with a +2 dioptre prescription will require 2 dioptres of accommodation to see an object clearly at infinity and therefore the total accommodation required to focus at 20 cm will be 7 dioptres.

For this reason the onset of presbyopia is earlier in hypermetropic patients than in emmetropic patients (the onset in low myopic patients is even later). See page 141, feedback to question 75, for an alternative method for approaching this type of problem.

16. D The uveal meshwork provides the greatest degree of resistance to aqueous humour outflow

The uveal meshwork is the first layer of the trabecular meshwork that the aqueous must pass through and has large intercellular spaces, and consequently a low resistance to aqueous flow. The next layer is the corneoscleral meshwork, which is a lamellar structure of connective tissue covered by endothelium-like cells. The final layer is the juxtacanalicular or 'cribriform' meshwork, which is embedded in an extracellular matrix composed of collagen, elastic fibres and proteoglycans. Contraction of the ciliary muscle causes expansion of the three-dimensional structure of the trabecular meshwork which results in enlargement of the intertrabecular spaces, and therefore reduction of the resistance to aqueous outflow.

17. A Fibrillin

The lens zonules are composed of microfibrils that are principally non-collagenous. The major constituent is fibrillin, a glycoprotein. They share similar properties to elastin, giving both tensile strength and elasticity. The fibrillar elements are surrounded by a layer of glycosaminoglycans (including hyaluronate) and other glycoproteins. This coating may include type IV collagen. Lens zonules are acellular.

18. B The epithelium is stratified squamous in the palpebral and limbal portions

The conjunctiva is a translucent mucous membrane composed microscopically of three layers (**Table 3.4**).

Table 3.4 Properties of the layers of the conjunctiva

Conjunctival epithelium	Non-keratinised, 2–7 layers: • Stratified squamous (palpebral and limbal) • Stratified columnar (bulbar) Other cells: goblet cells, melanocytes, dendritic cells, lymphocytes
Conjunctival epithelial basement membrane	Type IV collagen Anchoring fibrils and hemidesmosomes
Conjunctival stroma	Loose connective tissue: • Superficial lymphoid layer • Deep collagenous fibrous layer attached to Tenon's/episclera (apart from palpebral conjunctiva, where it adheres to tarsal plate)

19. B Dog faeces

The *Toxoplasma gondii* parasite reproduces in the intestinal mucosa of the cat, which is the definitive host, and the cysts pass into cat faeces. Other animals can ingest cysts from contaminated soil and become intermediate hosts, but dog faeces are more commonly a source of *Toxocara canis* infection.

Human infection is acquired following ingestion of cysts, either from contact with cat faeces, from contaminated and undercooked meat, or contaminated drinking water. Transplacental infection can also occur resulting in congenital toxoplasmosis.

20. B Left anterior descending artery

ST changes in leads V1–V4 suggest an anteroseptal infarct. This region is supplied by the left anterior descending artery.

The right coronary artery supplies the inferior (leads II, III and aVF) and posterior (reciprocal changes in leads V1–V3) areas. The right marginal artery is a branch of the right coronary artery.

The circumflex artery supplies the lateral area (leads I, aVL and V5–V6).

21. C There are approximately 3.7 million axons in the optic nerve

The optic nerve runs from the disc to the chiasm and is approximately 4–5 cm long. It is comprised of intraocular (1 mm), orbital (2.5 cm), intracanalicular (0.5–1 cm) and intracranial (1–1.5 cm) portions. Beyond the chiasm, the nerve fibres continue as the optic tracts.

It is composed of approximately 1.2 million axons, which arise from the retinal ganglion cells and synapse in the lateral geniculate body. Interestingly, during foetal development, optic nerve axons peak in number at around 16 weeks' gestation (3.7 million) and then decline to adult levels by the 3rd trimester.

The optic nerve is myelinated posterior to the optic disc, with the myelin coming from oligodendrocytes (as it does in the central nervous system) rather than Schwann cells.

22. B Layers V and VI project to the secondary visual cortex

The primary visual cortex is also known as V1, the striate cortex or Brodmann's area 17. It occupies the area around the calcarine sulcus on the medial surface of each occipital lobe. There is a sophisticated topographic representation of the retina within V1. Each primary visual cortex represents the contralateral visual field, with the upper field being represented below the calcarine sulcus and vice versa. The peripheral retina is represented anteriorly and the macula posteriorly. There are six layers in the primary visual cortex (**Table 3.5**).

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