9. Gas Exchange

9.1 The Gas Exchange System

Paper 2

Marking Scheme

Q1.

(a)(i)	**A** – ciliated epithelial (cell) **;** **R** ciliated epithelium **B** – goblet (cell) **;**	**2**

(a)(ii)	**1** goblet cells / **B**, secrete / produce / release, mucus / mucin **;** **2** mucus, covers / AW, the (ciliated) epithelium to trap (named) particles **;** **or** *idea that* mucus prevents (named) pathogens reaching, epithelial cells / alveoli / gas exchange surface **;** **I** lungs **A** acts as a barrier to (named) pathogens **3** cilia / ciliated epithelial cells, move mucus (and trapped material), upwards / towards mouth / towards throat **or** pharynx / away from alveoli / away from gas exchange surface / away from lungs / out of the airways **;** **I** 'out of the lungs' / 'to be swallowed' unqualified / out of the respiratory system / out of the gas exchange system	**3**

Q2.

(a)	*any **two** from:* **1** (by) contracts / contracting / contraction, and, relaxes / relaxing / relaxation **;** *must be in context of bronchioles* **R** if includes *ref. to* stretch / expand / recoil **R** if in context of *bronchus or trachea (then ecf in subsequent mps)* **2** diameter / lumen size, can be, controlled / changed **;** AW **A** contraction, decreases diameter (of lumen) / constricts **A** relaxation (after contraction) increases diameter (of lumen) / widens / dilates / expands **R** vasoconstriction / vasodilation **3** *idea of,* controls / regulates, flow of air / volume of air flowing **;** AW **I** statements such as 'lets air in' / 'allows inhalation and exhalation' **A** oxygen in / carbon dioxide out, *instead of air flow* **R** oxygen out and carbon dioxide **4** AVP **;** e.g. contract to, reduce air movement / prevent entry of contaminants *idea of* normally relaxed but can, contract / cause constriction, when needed *max 1 if response relates function to inhalation and exhalation* *0 marks if incorrectly stated as elastic tissue or elastic fibres*	**2**

Q3.

(d)(ii)	*any **three** from:* **1** alveolar cells / ECM, hindered / surrounded by / AW, *P. jirovecii* cells ; **A** alveolar wall becomes, thicker / AW **2** diffusion (of oxygen), impaired / decreased / AW ; **A** distance for diffusion increased **A** reduced surface area for diffusion ; **3** between, alveolus / alveolar air / alveolar space, and, capillary / blood / red blood cell(s) ; *allow mp if oxygen is clearly going in the correct direction* **4** less / AW, oxyhaemoglobin formed ; AW e.g. **A** less oxygen, binds to / taken up by / associates with, haemoglobin **A** less oxygen forms bonds with, Fe^{2+} / iron ion / iron, (in haemoglobin) **5** *idea of* ability of elastic fibres to, stretch / recoil, impaired / AW ; **A** *idea of* less elastic / decreased elasticity (of alveoli) **6** alveolar air not, refreshed / AW, so decreased diffusion gradient ; **7** AVP ; e.g. presence of macrophages hinders diffusion of oxygen *suggestion that P. jirovecii* infection, damages / AW, alveolar capillaries / venules / branches of pulmonary vein *suggestion that* oxygen used up for *P. jirovecii*, metabolism / activity / AW less ability of collagen to provide support to alveoli / AW	**3**

Q4.

(a)	**J** cartilage ; **K** smooth muscle ; *difference* **I** *ref. to* other tissues *plus **one** from:* cartilage in bronchus but not the bronchioles ; suggestion for smooth muscle tissue (*ref. to* **K**) ; e.g. proportionally more smooth muscle in the wall of the bronchiole	**3**

Q5.

(a)	bronchi / left and right bronchus ;	**1**
(b)	*any **two** from:* diffusion distance too great / AW ; **A** walls too thick for (efficient) diffusion **I** *ref. to* surface area time taken for diffusion (to occur) too long / diffusion rate too slow ; further detail ; e.g. many cell layers / a number of tissues, to pass across named tissue type(s) to cross e.g. presence of smooth muscle *ref. to* ciliated epithelium / not squamous epithelium *ref. to* layer of mucus on lining of gas exchange system *idea that*, ventilation / fast air flow, reduces time for (correct gradient to be established for) diffusion to occur ; *idea that* blood supply is, not from pulmonary artery / not pulmonary circulation / from a branch of the aorta / part of the systemic circulation ; **I** not enough, blood / blood vessels detail ; e.g. (systemic) blood supply to the gas exchange organs is, already oxygenated / not deoxygenated low / no, concentration gradient for, oxygen / carbon dioxide in (systemic) blood supply to the gas exchange organs	**2**
(c)(i)	as airway generation (number), increases / gets higher, airway diameter decreases ; AW **A** in terms of named structures or numbers **A** inverse correlation	**1**

(c)(ii)	*any **three** from:* *yes, useful* compared to Weibel Lung model measurements, similar results / same trend / same relationship between airway generation and airway diameter ; data to support ; projection / multi-Slice, for at least one generation, compared to Weibel (supporting trend) projection / multi-slice, 2 generations showing trend no risk of, harmful / radiation, exposure ; AW detail ; e.g. can repeat / can use regularly (on same person) can, follow progression of disease *if no reference made to 'yes' results, only allow one of these two marks** *not useful* not the same as / different to, Weibel's results ; projection results not consistent with multi-slice results / AW ; data to support ; *not same as Weibel's* projection **or** multi-Slice, for at least one generation compared to Weibel *projection and multi-slice not the same* projection **and** multi-Slice for at least one generation	**3**

Q6.

(a)(i)	cartilage ;	1
(a)(ii)	*any **two** from:* (smooth muscle) contracts (and relaxes) / contractile ; **R** bronchus contracts changes diameter of the airway / controls size of the lumen ; **A** *ref. to* constriction of bronchus (may) help to regulate airflow, into / away from, gas exchange surfaces ; AVP ;	2

Q7.

(a)	*any **one** from:* **I** too small presence of ciia ; **A** ciliated, cells / epithelial cells / epithelium AVP ; e.g. *suggestion that* mucus on surface makes detail not easily seen	1
(b)	epithelium has goblet cells and ciliated epithelial cells ; **A** ciliated cells **A** two different cell types present **I** *ref. to* cell division *ref. to* staining ; e.g. use of stains gives different, shades / colours differential staining one cell type more neutral / acidic different parts of cells stain differently *idea of* cells have different densities ; e.g. *idea of* more structures / larger nucleus, gives greater density / AW **R** no cell structures *for lighter cell* **I** *ref. to* number of cilia (sectioning may include) more of nucleus so, affects light penetration / makes cell darker ora AVP ; *idea of* different components in cells appearing, darker / lighter	2

(c)	*any **three** from:*			3
	A		**B / cartilage**	
	max two for structure			
	smooth muscle / composed of smooth muscle cells **or** no chondrocytes	**or**	no smooth muscle cells **or** has chondrocytes ;	
	cells close together	**or**	cells, (more) isolated / in gaps / in lacunae ;	
	cells, spindle shaped / elongated / AW	**or**	cells (more) rounded / AW ;	
	AVP structure e.g. not surrounded by, perichondrium / AW contains blood vessels	**or**	surrounded by, perichondrium / AW no blood vessels ;	
	function			
	contractile / contracts (and relaxes) **I** recoil **A** bronchi walls contract **R** bronchi contract	**or**	non-contractile ;	
	changes diameter of airways **A** controls size of lumen	**or**	protective / support ; **A** described e.g. prevents collapse of, bronchus **or** keeps bronchus open	
	*if incorrectly quotes **A** as the cartilage, use right hand column to allow one mark max (ecf)*			

Q8.

(a)	**A** – ciliated, epithelium / epithelial tissue ; **B** – smooth muscle ; **D** – cartilage ;	**3**
(b)	**1** produce / release / secrete, mucus / mucin ; **R** excrete mucus *any **two** from:* **2** mucus forms a layer over the (ciliated) epithelium ; **3** traps / sticks to, bacteria / viruses / pathogens / microorganisms / dust / pollen / (fungal) spores / AW ; **4** mucus is, moved / AW, away from alveoli *or* lung tissue / towards back of mouth / AW, by cilia ; **R** 'by ciliated cells' **5** *idea that* mucus prevents (named) pathogens reaching, epithelial cells / alveoli / gas exchange surface ; **A** acts as a barrier to (named) pathogens	**3**

Q9.

(a)	*any **two** from:* presence of mucus can, hinder / prevent / AW, gas exchange / entry of air (to alveoli) / airflow (to alveoli) ; **A** named gases detail ; e.g. (lumens of) airways / respiratory bronchioles, are narrow **or** airways / respiratory bronchioles, are close to alveoli *suggestion that* respiratory bronchioles *have*, few / no, cilia present so difficult to move mucus / AW ; **R** bronchioles do not have cilia *as a general statement* mucus increases distance for diffusion of (respiratory) gases / oxygen / carbon dioxide ; **R** if direction of diffusion of gas is incorrect increased risk of infection from trapped pathogens if mucus present ; AW	**2**
(b)(i)	*any **three** from:* (bronchioles) have columnar, epithelium / cells ; **A** columnar and cuboidal, epithelium / cells (bronchioles) have ciliated, epithelium / (epithelial) cells ; **A** cilia (are present) **ora** (alveoli) have squamous, epithelium / cells ; **I** endothelium / endothelial cells detail ; e.g. (bronchiole epithelial cells) longer / wider / thicker **R** if, mucus makes it thicker / stated as more than one layer **or** (alveolar cells) flatter / thinner *allow ideas if stated as epithelium (rather than cells)* AVP ; e.g. ref. to alveolar type II cells / cells secreting surfactant	**3**

(b)(ii)	smooth muscle ; *plus any **two** from:* *max 1 for function if stretch and recoil **or** vasoconstriction / vasodilation stated* (muscle) contracts / contraction (and relaxation of bronchiole, lining / wall) ; **R** contraction of, bronchiole / lungs / other airways change / decrease, diameter of, bronchiole / lumen / airway ; **A** adjust size of airway **A** constriction of, bronchiole / airway control of air flow (to and from alveoli) / AW ; e.g. control volume of air, entering / leaving, alveoli *allow ecf **max two marks** if incorrectly stated as elastic fibres* stretch / expand, during inhalation ; **A** stretch and recoil prevents, overstretching / bursting, during inhalation ; recoils to help move air out during exhalation; *allow ecf to **max one mark** if incorrectly stated as cartilage* prevent collapse of, bronchiole / airway ; provides support / keeps airway open ;	**3**

Q10.

(a)	*any three from* *lung cancer to max 2* (tar) is a carcinogen ; acts as mutagen / causes mutations / described ; **I** mutant cells e.g. causes changes to sequence of, bases / nucleotides, in DNA detail ; **I** uncontrolled mitosis e.g. tumour suppressor genes switched off protooncogenes to oncogenes / oncogenes switched on (cell cycle) checkpoints fail to function AW cell moves from, G0 / inactive state of cell cycle, to G1 phase (for mitosis) no programmed death / AW *chronic bronchitis to max 2* (tar) paralyses / destroys / damages / AW, cilia ; **I** weakens cilia **A** damage to ciliated (epithelial) cells consequence to cilia action ; *must be related to mp1* e.g. cilia do not, waft away / AW, mucus loss of synchronous rhythm of cilia (tar causes), goblet cells / mucous glands, to, increase in size / enlarge / AW ; **A** (tar / accumulation of mucus, causes) inflammation more / excess, mucus produced (by, goblet / mucous gland cells) ; **I** mucus accumulates	**3**

Q11.

(d)	*any two from (in emphysema)* alveolar walls break down / alveoli burst, to, produce one large air sac / give a lower SA:V **or** diseased, tissue / areas / alveoli, has lower SA:V (than healthy tissue) ; removed tissue has (higher proportion of), large air sacs / diseased alveoli ; remaining tissue has, healthy / undamaged / functional / only, alveoli ; AW **A** volume reduced and functional surface area of lung remains the same **A** remaining tissue has higher functional surface area (than before surgery)	**2**

Q12.

(c)(i)	trachea bronchus / bronchi bronchiole / bronchioles ; **A** types of bronchiole	**1**

Q13.

(b)(i)	*any two from* in trachea ; in, bronchus / bronchi ; *if only one correct structure named, allow one qualification mark* *trachea* C-shaped / incomplete, rings ; surround smooth muscle ; *bronchus* plates / irregular ;	**2**

(b)(ii)	*any two from* keep airways open ; provides support ; allow flexibility ; *allow described e.g. bending neck, swallowing food* rings allow, lengthening / widening, during, breathing in / inspiration / inhalation ;	**2**

Q14.

(a)	*any **one** from :* (*when the air pressure lowers inside bronchus*) holds, bronchus / airway open ; **A** supports, bronchus / airway ; prevents, bronchus / airway, from collapsing ;	**1**
(a)(ii)	*idea that* (cartilage arranged as) incomplete / C-shaped, rings in the trachea ; *idea of* more regular distribution (of incomplete rings) along the length of trachea ;	**1**
(a)(iii)	*max 1 if cilia or mucus linked to incorrect cell* (ciliated epithelial cells have) cilia, to, waft / sweep / AW, mucus, away / up the trachea / AW ; (goblet cells that) secrete mucus to trap, dust / bacteria / pathogens ;	**2**

Q15.

(a)	irregular / plates / AW, of cartilage ; **A** cartilage not C-shaped rings *other features* *any **two** from:* smooth muscle ; elastic, tissue / fibres ; mucous glands ; thick wall / wall many layers ; large lumen (relative to thickness of wall) ; large size relative to surrounding alveoli ; **I** surrounded by alveoli	**3**
(b)	*evidence must match stated structure* blood vessel ; *plus any **one** from:* presence of tunica media / circular layers of smooth muscle ; three layers in wall ; similar to structure on left, which has blood cells ; not bronchiole, qualified ; e.g. as no ciliated epithelium not rounded shape / no definite shape **OR** artery ; **A** arteriole *plus any **one** from:* small lumen relative to thickness of wall ; **A** small lumen with thick wall thick, tunica media / muscle layer ; thick tunica externa ; **OR** vein ; *plus any **one** from:* no definite shape / not rounded / not oval / AW ; large lumen relative to thickness of wall / large lumen and thin wall ; thin tunica media ;	**2**
(c)	goblet cells, produce / secrete / AW, mucus to trap, pathogens / AW ; **A** dust / dirt / particles etc for AW cilia, waft / moves / carries / push, mucus, to back of throat / AW ;	**2**

Q16.

(a)	EMRO and SEARO / Eastern Mediterranean and South-East Asia (Regions)	**1**

Q17.

(a)	mucous gland cells / mucous gland(s) ; **I** mucosa goblet cell(s) ; *list containing trachea and / or bronchus and / or bronchioles* ***I*** *and allow to two max* *BUT if alveoli stated or incorrect cell types (e.g. ciliated cells) max 1*	**2**

Q18.

(a)	*three from:* any four named structures ; mouth / nose / nostrils / nasal passages (count as one structure) pharynx larynx trachea **A** windpipe bronchus / bronchi bronchiole / bronchioles alveolus / alveoli / alveolar ducts / alveolar sacs lungs trachea, branches / divides, into (two main) bronchi ; correct sequence from bronchus (branching) to bronchioles to (end with) alveoli ; further detail ; ; e.g. trachea has, C-shaped / incomplete rings, of cartilage bronchus has cartilage, plates / AW diameters of gas exchange structures / respiratory tubes, decrease (towards alveoli)	**3**

Q19.

(a)	bronchiole ; **I** respiratory / terminal, before bronchiole	**1**

(c)	*any four from* *in healthy lungs* **1** correct direction of movement of <u>both</u> respiratory gases ; e.g. oxygen from alveolus towards blood and carbon dioxide from blood to alveolus ; oxygen enters the blood system and carbon dioxide leaves **A** red blood cell / haemoglobin, *as ref. to blood* **2** diffusion (of, oxygen / carbon dioxide) **or** movement, down a concentration gradient / from high(er) to low(er) concentration ; **A** implied e.g. oxygen enters blood from a high<u>er</u> concentration **I** diffusion of gases **3** detail of pathway ; **R** *ref. to* cell walls e.g. across, alveolar wall / squamous (epithelial) cells across endothelium / capillary wall ; **A** squamous cells *in context of capillary* crosses two layers of cells (*alveolar wall and capillary wall)* *comparison healthy with diseased – look for ora* **4** higher rate of exchange / increased rate of diffusion / steeper concentration gradient ; **A** more oxygen to blood per unit time / more carbon dioxide to alveolus per unit time **I** more efficient gas exchange **I** better gas exchange / faster diffusion **5, 6** AVP ; ; e.g. larger surface area (for, gas exchange / diffusion) shorter diffusion distance *ref. to* (greater) ability to, stretch / recoil (for ventilation to maintain gradient) **or** *ref. to* elasticity *(more v fewer elastic fibres is not sufficient)*	**4**

Q20.

(a)	**A** trachea ; **A** windpipe **I** *ref.* to cartilage rings **B** bronchiole ; **I** respiratory / terminal , before bronchiole **C** alveoli ; **A** alveolus / air sac / alveolar sac	**3**
(b)	*any one from* lung cancer ; emphysema ; chronic bronchitis ; COPD ; cystic fibrosis ; AVP ; e.g. asthma *must be non-infectious*	**1**