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Chapter 1

BASIC SCIENCES

Questions

1.1 Which one of the following is the main function of the Golgi apparatus?

☐ A It packages molecules into vesicles that can be transported out of a cell
☐ B It produces most of the cell’s energy requirements
☐ C It is responsible for bacterial phagocytosis
☐ D It regulates cell reproduction
☐ E Protein synthesis

1.2 Which one of the following is the definition of ‘apoptosis’?

☐ A Programmed cell death
☐ B Phagocytosis of nuclear material
☐ C Forward movement of the eyeball
☐ D Inflammation of the tendon sheath
☐ E Cell necrosis

1.3 Which one of the following is true with regard to cytokines?

☐ A Cytokines are produced exclusively by cells of the immune system
☐ B Interleukin 6 (IL-6) enhances albumin synthesis by the liver
☐ C Interleukin 2 (IL-2) is derived from wandering macrophages
☐ D $T_H$1 cells regulate allergic reactions and antibody production
☐ E Transforming growth factor $\beta$ (TGF-$\beta$) inhibits the production of other cytokines
1.4 Which one of the following statements about seminal fluid is true?

- A Semen is produced in the seminal vesicles and stored in the testes
- B In a human, complete maturation of spermatozoa takes approximately 3 hours
- C Up to 70% of the spermatozoa in an ejaculate are abnormal
- D The spermatozoon concentration may be temporarily suppressed by fever
- E Sildenafil (Viagra®) doubles the sperm count 3 months after the initiation of treatment

1.5 Which one of the following factors inhibits the release of renin?

- A Assumption of the erect posture
- B Overactive sympathetic adrenergic neurones
- C Salt depletion
- D Prostaglandins
- E Angiotensin II

1.6 Which one of the following muscles in the hand is supplied by the median nerve?

- A Lateral two interossei
- B Abductor pollicis brevis
- C Medial two lumbricals
- D Flexor pollicis longus
- E Extensor pollicis

1.7 Which one of the following statements is true regarding vasopressin?

- A It is synthesised in the posterior pituitary
- B It makes the proximal convoluted tubules more permeable to hypotonic fluid
- C It increases the concentrations of circulating factor VIII and von Willebrand factor
- D It inhibits the release of adrenocorticotropic hormone (ACTH) from the pituitary
- E It induces vasodilatation in splanchnic vessels
1.8 Osteopetrosis (marble bone disease) is characterised by sclerosis and obliteration of the bone marrow due to abnormal function of which one of the following cell types?

- A Osteoblasts
- B Osteoclasts
- C Chondrocytes
- D Synoviocytes
- E Macrophages

1.9 Which one of the following statements about physiological acclimatisation to high altitude is true?

- A It starts at an altitude of 1000 feet
- B The plasma volume increases
- C The haematocrit is reduced
- D There is increased renal excretion of bicarbonate
- E There is pulmonary hypoventilation

1.10 A 50-year-old woman is referred with general lethargy and excessive fatigue. The serum sodium is 117 mmol/l. You suspect that she has syndrome of inappropriate antidiuretic hormone secretion (SIADH). Which one of the following findings would be most typical of this syndrome?

- A Urinary sodium excretion of 10 mmol/l
- B Urine osmolality of 120 mosmol/kg
- C Plasma osmolality of 300 mosmol/kg
- D Serum potassium concentration of 3 mmol/l
- E Urine output of 2 litres/24 hours

1.11 Which one of the following is most likely to increase during exercise?

- A Peripheral vascular resistance
- B Pulmonary vascular resistance
- C Stroke volume
- D Diastolic pressure
- E Venous compliance
1.12 Which one of the following statements about hyponatraemia is accurate?

- A In heart failure it is associated with a poor prognosis
- B In liver cirrhosis it is often due to increased renal loss of sodium
- C When associated with hypo-osmolarity, paraproteinaemia should be considered
- D In the presence of low urea and low serum potassium levels, it is suggestive of Addison’s disease
- E Confusion and coma often ensue when serum sodium approaches 125 mmol/l

1.13 Which one of the following is higher at the apex of the lung than at the base of the lung when a person is standing?

- A $V/Q$ ratio
- B Ventilation
- C $P_{CO_2}$
- D Compliance
- E Blood flow

1.14 The primary neurochemical disturbance in idiopathic Parkinson’s disease involves which one of the following?

- A Noradrenaline (norepinephrine)
- B Dopamine
- C $\gamma$-Aminobutyric acid (GABA)
- D Substance P
- E Adrenaline (epinephrine)

1.15 Which one of the following pathological features is pathognomonic of the disease it is listed with?

- A Reed–Sternberg cells in Hodgkin’s disease
- B Aschoff nodules in rheumatic fever
- C Charcot–Leyden crystals in sputum from a patient with asthma
- D Alcoholic hyaline (Mallory body) from a liver biopsy specimen in alcoholic liver disease
- E Non-caseating granuloma in sarcoidosis
Chapter 1

BASIC SCIENCES

Answers

1.1  A: It packages molecules into vesicles that can be transported out of a cell

The Golgi apparatus consists of stacks of membrane-covered sacs that package and move proteins to the outside of the cell. The mitochondria are the enzyme-rich organelles that produce most of the ATP energy. The centriole is involved in cell division. The ribosome contains ribonucleic acid molecules and enzymes that are required for manufacturing proteins. Phagocytosis is not a function of the Golgi apparatus.

1.2  A: Programmed cell death

Apoptosis is defined as ‘programmed cell death’. This occurs in individual cells, with no associated inflammatory reaction, in contrast to cell necrosis. It is a crucial process in embryogenesis, when tissue building, replacement and moulding are at their peak. Unopposed apoptosis with progressive destruction of specific groups of nerve cells is thought to be one of the processes that ultimately leads to Alzheimer’s disease. On the other hand, inhibition of apoptosis, with prolonged cell survival, may have a determinant role in the induction of autoimmunity (prolonging immunocompetent cell survival). Similarly, in lung cancer, genetic abnormalities such as mutation of the oncogene TP53 can lead to loss of tumour suppression function, inhibition of apoptosis and increased cellular proliferation. Recent investigation of bone
marrow myeloid progenitor cells in myelodysplasia and cyclic neutropenia suggests that intramedullary apoptosis is a central feature regulating cell loss in this disorder. The pathogenesis of ischaemic heart disease involves cell death due to necrosis and this is associated with a local inflammatory reaction. Proptosis is forward movement of the eyeball. Tenosynovitis is inflammation of the tendon sheath.

1.3  **E: Transforming growth factor β (TGF-β) inhibits the production of other cytokines**

Cytokines are hormone-like proteins that enable the immune cells to communicate. They play an important role in initiation, perpetuation and subsequent down-regulation of the immune response. They are produced by immune system cells and also by non-immune system cells such as fibroblasts and endothelial cells. Interleukin 6 (IL-6) enhances the production of the acute-phase reactant proteins in the liver but does not enhance the production of albumin, which is not an acute-phase reactant. IL-2, produced by T cells, increases expression of its own receptor on T cells and markedly enhances T-cell proliferation. Distinct subsets of helper T cells have been identified by virtue of the cytokines that they produce: T_{H1} cells regulate delayed-type hypersensitivity reactions and T_{H2} cells mediate allergic and antibody responses.

1.4  **D: The spermatozoon concentration may be temporarily suppressed by fever**

Normal ejaculate volume ranges from 2 ml to 6 ml. The normal range of spermatozoon concentration is 20–200 million per ml and up to 20% are morphologically abnormal. More than 60% of spermatozoa examined within 1 hour after ejaculation are motile. In any individual, sperm counts exhibit extreme variability and are often temporarily suppressed by factors such as fever. In a human it takes approximately 3 months for complete maturation of a spermatozoon. Semen is produced in the testes and stored in the seminal vesicles. Sildenafil (Viagra®) has been licensed for the treatment of impotence. It causes vasodilatation of the corpora cavernosa blood vessels and so increases the blood flow and maintains erection in the penis. Viagra® has no direct effect on sperm count or fertility.
1.5 **E: Angiotensin II**

Renin is a glycoprotein of 274 amino acids and is produced in the juxtaglomerular cells of the afferent renal arteriole. It converts angiotensinogen to angiotensin I. It is stimulated by a lowering of the blood pressure. Angiotensin II and vasopressin inhibit renin release.

1.6 **B: Abductor pollicis brevis**

The median nerve supplies the following structures in the hand:

- abductor pollicis brevis, flexor pollicis brevis, opponens pollicis
- lateral two lumbricals
- the skin of the lateral three and half fingers.

The ulnar nerve supplies all the interossei and the rest of the hand muscles.

1.7 **C: It increases the concentrations of circulating factor VIII and von Willebrand factor**

Arginine vasopressin (AVP; antidiuretic hormone, ADH) is synthesised in the supraoptic and paraventricular nuclei of the hypothalamus. V2 receptors mediate its antidiuretic effect. It makes the distal convoluted tubules more permeable to hypotonic fluid. It stimulates ACTH release and increases concentrations of circulating factor VIII and von Willebrand factor. By stimulating V1 receptors it causes vasoconstriction of splanchnic, renal and coronary vessels, and promotes glycogenolysis.

1.8 **B: Osteoclasts**

Osteopetrosis is an inherited disorder characterised by increased bone density. In severe forms the bone marrow cavity may be obliterated. The primary underlying defect in all types of osteopetrosis is failure of the osteoclasts to reabsorb bone. This results in thickened sclerotic bones. Radiological features are usually diagnostic. Bones may be uniformly sclerotic.
1.9 **D: There is increased renal excretion of bicarbonate**

Physiological acclimatisation starts at about 7000 feet (2100 m). The partial pressure of atmospheric oxygen reduces with altitude. Pulmonary ventilation and perfusion increase, plasma volume decreases and renal excretion of bicarbonate increases. These changes serve to maintain the arterial oxygen tension. Erythrocyte production increases and the haemoglobin concentration and haematocrit increase. Above 1400 feet, the heart rate, cardiac output and pulmonary artery pressure increase. Alveolar hypoventilation, hypoxia and cyanosis are features of chronic mountain sickness when the physiological response of acclimatisation is no longer maintained.

1.10 **B: Urine osmolality of 120 mosmol/kg**

The main features (diagnostic criteria) of SIADH consist of hyponatraemia and hypotonicity (<280 mosmol/kg), the absence of fluid volume depletion, inappropriately high urinary osmolality (>100 mosmol/kg), and increased urinary sodium excretion (>40 mmol/l) while on a normal salt and water intake, and the absence of thyroid, adrenal, pituitary or renal dysfunction. Although a low serum potassium concentration and a normal urine output are consistent with the diagnosis of SIADH, they are not exclusive to SIADH (neither their presence nor their absence would confirm or exclude this diagnosis).

1.11 **C: Stroke volume**

During exercise, increased oxygen consumption and increased venous return to the heart result in an increase in cardiac output and an increase in blood flow to both skeletal muscle and the coronary circulation, when oxygen utilisation is greatest. The increase in cardiac output is due to an increase in both heart rate and stroke volume. The systemic arterial pressure also increases in response to the increase in cardiac output. However, the fall in total peripheral resistance, which is caused by dilatation of the blood vessels within the exercising muscles, results in a decrease in the diastolic blood pressure. The pulmonary vessels undergo passive dilatation as more blood flows into the pulmonary circulation. As a result, pulmonary vascular resistance decreases.
The decrease in venous compliance, caused by sympathetic stimulation, helps to maintain ventricular filling during diastole.

1.12 **A: In heart failure it is associated with a poor prognosis**

In heart failure, reduced cardiac output will cause reduced renal blood flow, increase of aldosterone secretion and sympathetic activity, which result in salt and water retention by the kidneys. ADH is increased in heart failure, causing further limitation of free water excretion. Together with the increased thirst in patients with advanced heart failure, this leads to a hyponatraemic state that is a particularly ominous prognostic sign. Hyponatraemia in liver disease is typically due to a combination of reduced renal clearance of free water and administration of excessive free water. Mineralocorticoid deficiency causes increased urinary clearance of sodium with volume contraction and increased ADH, which reduces free water excretion. The clinical features of hyponatraemia generally manifest when the serum sodium concentration falls to 120 mmol/l or less. Paraproteinaemia causes false hyponatraemia (with normal osmolarity) due to displacement of more fluid in the serum, which gives falsely low sodium readings.

1.13 **A: $V/Q$ ratio**

The alveoli at the apex of the lung are larger than those at the base, so they are less compliant. Because of the reduced compliance, less inspired gas goes to the apex than to the base. Also, because the apex is above heart level, less blood flows through the apex than through the base. However, the reduction in air flow is less than the reduction in blood flow, so that the $V/Q$ ratio at the top of the lung is greater than it is at the bottom. The increased $V/Q$ ratio at the apex makes the $P_{\text{aCO}_2}$ lower and the $P_{\text{aO}_2}$ higher at the apex than they are at the base.

1.14 **B: Dopamine**

The pathogenesis of Parkinson’s disease is multifactorial, characterised by progressive death of heterogeneous populations of neurones, particularly in the substantia nigra, and resulting in a
regional loss of the neurotransmitter dopamine. A 60–70% loss of neurones occurs prior to the emergence of symptoms.

1.15 B: Aschoff nodules in rheumatic fever

A ‘pathognomonic’ symptom or sign is a symptom or sign unique to a particular disease. The presence of such a symptom or sign allows positive diagnosis of the disease. Although the histological diagnosis of Hodgkin’s disease requires the presence of Reed–Sternberg cells, these cells are not pathognomonic of the disease and have been described in infectious mononucleosis, other viral infections, and malignancies. Aschoff nodules, considered pathognomonic of rheumatic fever, consist of a central area of fibrinoid surrounded by lymphocytes, plasma cells, and large basophilic cells, some of which are multinucleated. Charcot–Leyden crystals (CLCs) have been found in many conditions associated with eosinophilia. Crystals of CLC protein in body fluids and secretions have long been considered a hallmark of eosinophil-associated allergic inflammatory diseases such as asthma, allergic rhinitis and atopic dermatitis. Alcoholic hyaline (Mallory body) is not specific for alcoholic liver disease because it has been detected in the livers of patients with Wilson’s disease, primary biliary cirrhosis, hepatic carcinoma and also following jejuno-ileal bypass. The presence of non-caseating granuloma should not be construed as diagnostic of sarcoidosis until a thorough investigation of other causes of granulomatous inflammation has been conducted.

1.16 B: Exercise

Growth hormone (GH) is synthesised, stored, and secreted by the endocrine cells of the anterior pituitary. Its release is stimulated by growth hormone-releasing hormone and inhibited by somatostatin. Numerous factors stimulate GH release, including hypoglycaemia (eg insulin administration), moderate to severe exercise, stress due to emotional disturbances, illness, fever, and dopamine agonists such as bromocriptine.

1.17 E: The nucleus

Receptors for steroid and thyroid hormones are located inside the