



bio letters

D2.3 Topical Questions Markscheme

Biology

Standard and Higher level

Paper 2

Question			Answers	Total
1.	a		solvation is the interaction of a solvent particle with a solute particle	1
1.	b		ionic and polar particles	2
1.	c		a. glucose contains many polar hydroxyl groups b. polar water molecules form hydrogen bonds with hydroxyl groups c. the partial negative charge of oxygen is attracted to the partial positive charge of hydrogen d. glucose-glucose interactions are disrupted and hydration shells form around glucose molecules	3

Question			Answers	Total
2.	a		fatty acids	1
2.	b		a. hydration shells prevent solutes from re-attracting in solution by forming solute-solvent interactions b. this helps to stabilize solutions and keep solutes dissolved	2
2.	c		a. water is polar with a partially negative oxygen (δ^-) and partially positive hydrogens (δ^+) b. the partially charged atoms in water allow the molecule to form hydrogen bonds with polar molecules c. the partially charged atoms in water allow the molecule to form polar interactions with ionic particles	3

Question			Answers	Total
3.	a		net zero water movement between solutions (rate of water exit from both solutions is equal)	1
3.	b		a. osmolarity is an expression of concentration b. tonicity describes the effect of solute concentration on water movement relative to another solution	2
3.	c		a. solutions with high solute concentration have less free water molecules than solutions with lower solute concentration more free water molecules b. free water molecules move randomly in all directions, so on average, the solution with more free water molecules will have more random collisions with the membrane per unit time, which increases the probability of passage through the membrane c. thus, statistically, more water will exit the dilute side than will exit the concentrated side until both solutions reach the same solute concentration (i.e. reach dynamic equilibrium)	3

Question			Answers	Total
4.	a		a. turgor pressure is the force exerted by plant cell contents against the cell wall b. plant cells gain water when bathed in hypotonic media c. water storage leads to expansion of vacuoles, which presses cell contents against the cell wall d. turgor pressure continues to increase until dynamic equilibrium is reached	2
4.	b		a. freshwater unicellular organisms continuously gain water because their surroundings are hypotonic b. contractile vacuoles collect and expel excess water, preventing excessive swelling and lysis c. multicellular animal organisms have developed organs (kidneys) and chemical signalling mechanisms (hormones like ADH) to regulate osmolarity d. multicellular plant organisms have developed cell walls to resist turgor pressure	3
4.	c		a. isotonic solutions have an effective osmotic concentration that produces no net movement of water into or out of cells b. isotonic solutions thus maintain cell volume and prevent damage c. intravenous fluids are isotonic to avoid excessive swelling/lysis in hypotonic conditions or shrinkage/crenation in hypertonic conditions d. organs for transplantation are bathed in isotonic solutions to reduce osmotic damage before surgery	4

Question			Answers	Total
5.	a		water potential (ψ) is the potential energy of water per unit volume (units are usually kilopascals (kPa))	1
5.	b		a. water potential is impossible to measure because it is comparative and only meaningful when used relative to another solution b. the potential of pure water is, by convenience of definition, designated a value of zero (although pure water contains plenty of potential energy, that energy is ignored)	2
5.	c		a. solutions with high solute concentration have less free water molecules (lower water potential) than solutions with lower solute concentration more free water molecules b. free water molecules move randomly in all directions, so on average, the solution with more free water molecules (higher water potential) will have more random collisions with the membrane per unit time, which increases the probability of passage through the membrane c. thus, statistically, more water will exit the dilute side than will exit the concentrated side until both solutions reach the same solute concentration (i.e. reach dynamic equilibrium)	3

Question			Answers	Total
6.	a		plasmolysis is the separation of the plasma membrane from the cell wall following loss of water from a plant cell by osmosis	1
6.	b		a. solute potential (ψ_s) represents the effect of dissolved solutes on water potential b. pressure potential (ψ_p) represents the effect of turgor pressure on water potential	2
6.	c		a. pure water is assigned a potential of zero (the maximum ψ_s) b. adding solutes lowers the potential energy of water (since ψ_s becomes more negative) c. ψ_p is positive when water is under pressure/compression, such as in a turgid plant cell d. ψ_p is zero when no pressure above atmospheric pressure is applied e. ψ_p is negative when water is under tension like in xylem	4

Question			Answers	Total
7.	a		a. standard deviation (SD) measures how far the trials are from the mean b. small SD indicates that the plant tissue measurements are consistent c. standard Error (SE) measures how far the mean is from the true mean d. a small SE indicates that the calculated mean is likely to be a precise estimate of the true mean response of the tissue at that concentration	4
7.	b		a. solute particles interact with water molecules through solute-solvent non-covalent interactions b. solute-solvent interactions stabilize the solution and lower its potential energy relative to pure water c. addition of solutes lowers solute potential which therefore lowers water potential d. if pressure potentials are equal, more concentrated solutions have a lower water potential, so a water potential gradient is established	4
7.	c		a. water movement is from higher to lower water potential b. the accumulation of mineral ions in root cells lowers solute potential and thus water potential, which promotes water uptake from the soil c. differences in water potential lead to water movement, which increases pressure potential and creates turgid cells that help support plant tissue d. negative pressure potential in xylem due to transpiration helps to draw water from roots to stem to maintain plant hydration e. translocation of sucrose in phloem depends on creating hydrostatic pressure by osmosis f. sucrose loading reduces ψ_s thus ψ_w which draws water from nearby xylem which has a higher ψ_w g. entry of water increases pressure potential which increases hydrostatic pressure at the source h. sucrose unloading at a sink reduces ψ_s so ψ_w rises and water flows back by osmosis into xylem	7

Question			Answers	Total
8.	a		a. in a hypotonic medium, animal cells gain water & swelling occurs, which may eventually lead to bursting (lysis) b. in a hypertonic medium, animal cells lose water & shrinkage occurs, which produces a characteristic wrinkled appearance (crenation) c. in a hypotonic medium, plant cells gain water & store it in vacuoles so they become more turgid but do not burst due to their rigid cell walls d. in a hypertonic medium, plant cells lose water from their vacuoles and may undergo plasmolysis (detachment of the plasma membrane from the cell wall)	7
8.	b		a. transport of NaCl in the ascending limb of the Loop of Henle increases ψ_s in the medulla which lowers ψ_w b. since the ascending limb is impermeable to water, the low water potential is maintained c. the descending limb is permeable to water so water moves from the filtrate (high water potential) to the medulla (low water potential) d. countercurrent flow maintains this water potential gradient to facilitate water reabsorption from the collecting duct	4
8.	c		a. animal cells bathed in hypertonic intravenous fluid will lose water because the cells have lower solute concentration than the intravenous fluid b. this will cause cells to shrink and crenate, which disrupts cellular function c. red blood cell oxygen carrying capacity will be negatively affected d. white blood cell immune function will be negatively affected e. cell volume in surrounding body tissue will be negatively affected	4