6.2.1 Cloning and biotechnology

(a)	(i) natural clones in plants and the production of natural clones for use in horticulture	To include examples of natural cloning and the methods used to produce clone (various forms of vegetative propagation).
	(ii) how to take plant cuttings as an example of a simple cloning technique	Dissection of a selection of plant material to produce cuttings. PAG2 HSW4
(b)	(i) the production of artificial clones of plants by micropropagation and tissue culture	To include an evaluation of the uses of plant cloning in horticulture and agriculture. HSW9, HSW12
	(ii) the arguments for and against artificial cloning in plants	
(c)	natural clones in animal species	To include examples of natural clones (twins formed by embryo splitting).
(d)	(i) how artificial clones in animals can be produced by artificial embryo twinning or by enucleation and somatic cell nuclear transfer (SCNT)	To include an evaluation of the uses of animal cloning (examples including in agriculture and medicine, and issues of longevity of cloned animals). HSW9, HSW10, HSW12
	(ii) the arguments for and against artificial cloning in animals	
(e)	the use of microorganisms in biotechnological processes	To include reasons why microorganisms are used e.g. economic considerations, short life cycle, growth requirements AND processes including brewing, baking, cheese making, yoghurt production, penicillin production, insulin production and bioremediation.
(f)	the advantages and disadvantages of using microorganisms to make food for human consumption	To include bacterial and fungal sources. HSW9, HSW12
(g)	(i) how to culture microorganisms effectively, using aseptic techniques	An opportunity for serial dilutions and culturing on agar plates.
	(ii) the importance of manipulating the growing conditions in batch and continuous fermentation in order to maximise the yield of product required	PAG7 HSW4
(h)	(i) the standard growth curve of a microorganism in a closed culture	An opportunity for serial dilutions and the use of broth. M0.1, M0.3, M0.5, M1.1, M1.3, M2.5, M3.1, M3.2, M3.4, M3.5, M3.6 PAG7 HSW4
	(ii) practical investigations into the factors affecting the growth of	

microorganisms

(i)	the uses of immobilised enzymes in biotechnology and the different methods of immobilisation.	To include methods of enzyme immobilisation AND an evaluation of the use of immobilised enzymes in biotechnology examples could include: • glucose isomerase for the conversion of glucose to fructose • penicillin acyclase for the formation of semi-synthetic penicillins (to which some penicillin-resistant organisms are not resistant) • lactase for the hydrolysis of lactose to glucose and galactose • aminoacyclase for production of pure samples of L-amino acids • glucoamylase for the conversion of dextrins to glucose • nitrilase for the conversion of acrylonitrile to acrylamide (for use in the plastics industry). M0.2, M0.3, M1.2, M1.3, M1.4, M1.6, M1.10, M3.2, M4.1 PAG4 HSW4