QWC

Marks can only be awarded where candidates express themselves clearly and coherently and use the correct biological terms and expressions indicated in the mark scheme.

Section A

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold

1 **(a)** **(i)** A: pollen grain;
B: tube nucleus/vegetative nucleus;
C: embryosac; [3]

(ii) mitosis; [1]

(iii) diploid zygote;
triploid primary endosperm nucleus; [2] [6]

2 **(a)** ribosome; [1]

(b) **(i)** CCU;

(ii) UUC;

(iii) peptide bond; [3] [4]

3 **(a)** Phylum A: Platyhelminthes/flatworms;
Phylum B: Cnidaria;
Phylum C: Annelida/Chordata; [3]

(b) acoelomate/dorsoventral flattened/bilateral symmetry/digestion mainly intracellular; [1] [4]

4 **(a)** **(i)** To maintain a constant pH; [1]

(ii) To maintain an isotonic solution/to prevent osmotic lysis; [1]

(b) **(i)** Hydrogen removed from succinate/hydrogen removed in Krebs cycle;
hydrogen/electrons passed along the respiratory chain;
oxygen acts as the final acceptor; [3]

(ii) oxygen used up; [1]

(iii) Mitochondria cannot metabolise glucose/glucose is metabolised in the cytoplasm/glucose is metabolised during glycolysis; [1]

(c) ADP is required for oxidative phosphorylation;
phosphorylation is necessary for the operation of the respiratory chain;

without the operation of the respiratory chain no oxygen is used/oxidative phosphorylation is not just associated with the respiratory chain but is tightly coupled to it/the slight rise initially is due to residual ADP within the mitochondria; [3] [10]

5 **(a)**

Smooth and yellow	312.75
wrinkled and yellow	104.25
smooth and green	104.25
wrinkled and green	34.75

½ mark each [2]

(b) There is no significant difference between the observed F_2 ratio and the anticipated F_2 ratio, any difference between the two ratios is due solely to chance; [1]

(c) 3;
> 0.9;
accept; [3]

(d) The alleles controlling seed texture and colour in peas are segregating independently of each other; [1] [7]

6 **(a)** A Chloroplast envelope
B starch grain
C thylakoids/grana/lamellae
D lipid droplet
E stroma

Five for [4], four for [3], three for [2] marks and two for [1] [4]

(b) **(i)** Chlorophyll molecules are excited by light; [1]

(ii) DCPIP turns colourless; [1]

(iii) DCPIP solution without extract (or with boiled extract), to show that living chloroplasts are the source of the electrons/there is no other source of the electrons;

DCPIP solution with extract in the dark, to show that light is the agent for electron release; [2]

(iv) Electrons picked up by electron acceptor;
flows through electron transfer system with the production of ATP (photophosphorylation);
finally reduces NADP to produce $NADPH_2$; [3]

(v) Repeat experiment in the dark;
if mitochondria present, DCPIP would be decolorised;
chloroplasts would have no influence, since they are inactive in the dark;

or

Repeat experiment at low temperature (eg 5°C);
if mitochondria present, there would be a decreased rate of colour change (due to suppressed mitochondrial activity);
chloroplast activity would remain the same, since photochemical activity is not temperature sensitive; [3] [14]

7 **(a)** **(i)** Codominance – both alleles in a genotype are expressed (functional proteins produced by each)/where the heterozygote has a phenotype distinct from either homozygote; [1]

(ii) Lethal gene – one genotype produces sufficiently drastic effects to kill the bearers of that genotype (often at an early stage of development); [1]

(iii) Multiple alleles – there are more than two different forms of the same gene; [1]

(iv) Sex linkage – a gene located on a chromosome determining sex/where the inheritance of the alleles of a gene is influenced by the gender of an organism/where reciprocal crosses give different results; [1]

(b) **(i)** bbT^bT^b;
bbT^AT^A, bbT^AT^M, bbT^AT^b;
BBT^MT^M, BBT^MT^b, BbT^MT^M, BbT^MT^b;

½ for each correct genotype [4]

(ii) Gametes possible:

genotypes accurately shown;
phenotypes accurately shown;
phenotype ratio;

BbT^AT^b × BbT^MT^b

BT^A BT^b bT^A bT^b BT^M BT^b bT^M bT^b

	BT^M	BT^b	bT^M	bT^b
BT^A	BBT^AT^M	BBT^AT^b	BbT^AT^M	BbT^AT^b
BT^b	BBT^MT^b	BBT^bT^b	BbT^MT^b	BbT^bT^b
bT^A	BbT^AT^M	BbT^AT^b	bbT^AT^M	bbT^AT^b
bT^b	BbT^MT^b	BbT^bT^b	bbT^MT^b	bbT^bT^b

black, Abyssinian	**6**
black, mackerel	**3**
black, blotched	**3**
brown, Abyssinian	**2**
brown, mackerel	**1**
brown, blotched	**1**

[5] [13]

8 **(a)** **(i)** A cell with more than twice the normal haploid number of chromosomes; [1]

(ii) Autopolyploid cells contain twice the normal haploid number of chromosomes but all the chromosomes are from the same species;

allopolyploid cells result from the hybridisation of two species;

and as a result contain twice the normal haploid chromosome number but the chromosomes are from two different species; [3]

(iii) Plants would have an increased size/greater hardiness/increased resistance to disease/any other appropriate answer; [1]

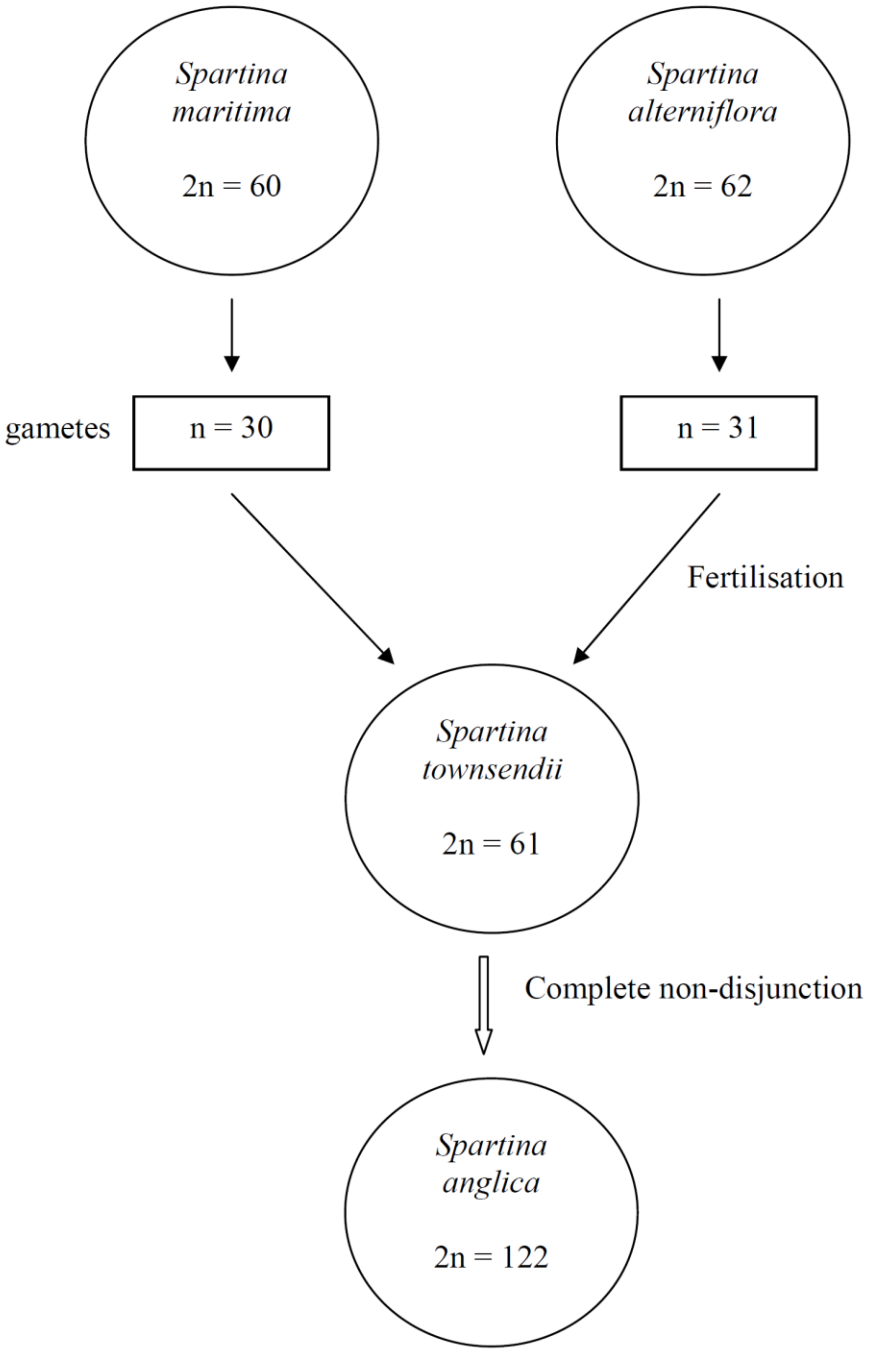
(b) **(i)** Allows for the halving of chromosome number;
allows for the segregation of the alleles at each gene locus; [2]

(ii) **Autopolyploid** may affect the ability of meiosis to produce daughter cells with a balanced set of chromosomes and so affect fertility (especially in autotriploids);

hybrids cannot form homologous chromosome pairs and so normal chromosome segregation cannot occur to produce viable gametes; [2]

(ii) Chromosomes now have homologous chromosomes to pair up with which allows meiosis to take place; [1]

(c)



Haploid number of gametes;
Diploid number of *Spartina townsendii*;
Complete non-disjunction;
Diploid number of *spartina anglica*; [4] [14]

9 Sixteen points (with at least five from each section)

Transgenic plants:

- isolating a desired gene from chromosomal DNA cut into fragments using restriction endonuclease
- the DNA is cut either side of the gene (and not in the middle of the gene) by choosing a particular restriction enzyme (out of hundreds available)
- identification of the DNA fragment containing the required gene by a gene probe/'Southern blotting' technique
- restriction enzymes producing 'sticky' ends are most useful (as the DNA fragment will more readily attach to the vector opened with the same restriction enzyme since the exposed bases are complementary)
- when plant cells are to be modified, the gene is inserted into a Ti ('tumor-inducing') plasmid
- opened by restriction endonuclease (the same one as used to obtain DNA fragments so that 'sticky' ends produced are complementary) with 'cut' ends sealed (annealed) using DNA ligase
- the recombinant Ti plasmid is introduced into the bacterium *Agrobacterium tumefaciens*
- which readily invades plant tissue that has had the cellulose wall digested (it will naturally reform afterwards)
- example of genetically engineered plants (eg 'Flavr Savr' tomato, roll leaf virus resistant potato, thioesterase oil seed rape)

Gene therapy:

- genetic disorders are caused by an absent or faulty gene/an incorrect nucleotide sequence
- resulting in a non-functional protein (or no protein) being produced and so abnormal metabolism
- example of genetic disorder (eg in cystic fibrosis the chloride ion membrane-pump is non-functional)
- gene therapy as the introduction of a functional gene to restore normal metabolism (and so eliminate the disease)
- isolation and identification of the normal gene using restriction enzymes and gene probes

- problems of introducing the gene into sufficient somatic cells
- introducing the gene for curing cystic fibrosis into the lungs using liposomes
- other example of gene therapy (eg inserting the gene coding for the enzyme adenine deaminase (ADA) into the blood cells of people suffering from severe combined immune deficiency (SCID) has been used to 'cure' the symptoms of SCID)

Human genome project:

- genome of an organism as the complete DNA sequence (on one set of chromosomes)
- genome sequencing as the determination of the order of nucleotides (bases) and so the genetic code
- human genome project determines the sequence of approximately 3 million nucleotides in the human genome
- and identifying all the genes (approximately 25 000)
- knowledge of the genetic code allows the structure of proteins to be determined
- the human genome project supports the use of gene therapy
- supports genetic testing whereby DNA 'chips' can be used to determine if an individual is a carrier of a genetic disorder
- supports improved diagnostics to test for the presence of genes that increase susceptibility of a person to a disease (eg cancer or heart disease)
- supports the development of 'designer' drugs matched to an individual's genetic profile [16]

Quality of Written Communication

2 marks

The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

1 mark

The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks

The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.