MEIOSIS AND VARIATION

ANSWERS & MARK SCHEMES

QUESTIONSHEET 1

FEATURE	MITOSIS	MEIOSIS	
Involves two successive nuclear divisions	✗	✓	;
Does not occur in a haploid cell	✗	✓	;
Involves synapsis forming bivalents	✗	✓	;
Involves chiasmata formation	✗	✓	;
Leads to random assortment of chromatids	✗	✓	;
Leads to random assortment of chromosomes	✗	✓	;
Occurs during gamete formation in a mammal	✓	✓	;
Daughter nuclei have identical genetic content	✓	✗	;
DNA replicates before cell division commences	✓	✓	;
Involves two chromosomal replications	✗	✗	;

TOTAL 10

QUESTIONSHEET 2

1. random assortment of chromosomes in Anaphase I;
   produces new combinations of chromosomes and the genes/alleles they carry from each homologous pair;
   resulting nuclei thus have new combinations of the genes/alleles present; **3**

2. random assortment of chromatids during Anaphase II;
   produces new combinations of alleles in the regrouped chromatids;
   resulting nuclei thus have new combinations of the alleles present; **3**

3. chiasmata form between chromatids of different but homologous chromosomes;
   thus moving alleles from chromosome to chromosome into new combinations;
   thus modifying the linkage groups present; **3**

TOTAL 9

QUESTIONSHEET 3

(a) B A C; A= anaphase, B = prophase, C = telophase; **2**

(b) Structure:
chromosomes would be replicated into chromatids;
chiasmata would be showing between chromatids of homologous chromosomes;

Arrangement:
chromosomes would be arranged into homologous pairs;
with centromeres attached to the opposite spindles; **4**

(c) (i) 2;
(ii) 4;
(iii) 6; **3**

TOTAL 9

QUESTIONSHEET 4

(a) in animals consists of a furrowing/tucking in of the cell membrane;
eventually separating two nuclei by constriction (of cytoplasm);
in plants a cell plate/ middle lamella is synthesised between nuclei;
calcium /magnesium pectate/cellulose secreted to form new cell wall; **4**

(b) centromere in chromosome holds chromatids together;
provides attachment to spindle during cell division;
centriole is made of microtubules (in animal cells);
forms spindle during cell division; **4**

(c) synapsis is pairing of homologous chromosomes;
in zygotene/early prophase of meiosis;
chiasmata formation occurs in diakinesis/late prophase of meiosis;
is cross over of genetic material between chromatids of homologous chromosomes; **4**

TOTAL 12

QUESTIONSHEET 5

(a) DNA double helix unwinds to give single stranded (primer) DNA;
upon which the complementary strand is assembled;
from surrounding nucleotides;
forming double stranded daughter DNA;
thus each new DNA has one strand from parent DNA and one new strand; **max 4**

(b) genes consist of alleles at corresponding loci on homologous chromosomes;
all alleles on a particular chromosome/chromatid must be carried together during inheritance;
chiasmata will swap some of these alleles with those on the sister chromosome;
thus the allelic make up of the linkage groups is modified; **4**

(c) meiosis reduces two sets of chromosomes to one set/diploid state to haploid state;
fertilisation joins two haploid nuclei together restoring the diploid state; **2**

TOTAL 10

QUESTIONSHEET 6

(a) A = chromatid; B = spindle fibre; C = centriole; D = centromere; E = chiasma; **5**

(b) (i) mitosis;
(ii) metaphase;
(iii) meiosis;
(iv) early anaphase I; **4**

(c) cell 2;
it is purely random which chromosomes of the homologous pairs go to a particular pole;
thus groups of alleles/linkage groups are mixed up in random fashion;
giving continuous variation; **3**

(d) will mix up alleles between linkage groups into new combinations;
giving (more) variation; **2**

TOTAL 14

QUESTIONSHEET 7

(a) (i) two homologous chromosomes that have paired closely together; **1**

(ii) meiosis; early prophase I/zygotene; **2**

(iii) synapsis; **1**

(b) A = centromere; B = chromatid; C = chromosome; D = chiasma; **4**

(c) (early) anaphase;
centromeres have moved apart;
but chiasma is still intact/not yet completed; **3**

TOTAL 11

QUESTIONSHEET 8

(a) (i) where there are clear-cut alternatives of a given trait;
with no intermediate forms;
tall and short peas/round and wrinkled peas/pigmentation and albinoism/any other valid examples;; (any two examples) **4**

(ii) where a given trait has many variations;
with only minor differences between them;
height in humans/intelligence/yield in crop plants/any other valid examples;;(any two examples) **4**

(b) genes contain two or more different forms called alleles;
at corresponding loci on homologous chromosomes;
thus any individual will have two alleles of the gene;
if the gene only has two alleles the number of characters available for expression will only be two (thus giving discontinuous variation);
if a gene has many alleles (polygene) then many variations of the character can occur;
individual can inherit any two of the variety of alleles (thus continual variation occurs); **max 5**

TOTAL 13

QUESTIONSHEET 9

(a) random assortment of chromosomes (at anaphase I);
random assortment of chromatids (at anaphase II);
chiasmata formation (in late prophase I/diakinesis); **3**

(b) alleles mixed together from two individuals;
these alleles may be different forms of the gene thus causing different effects; **2**

(c) most genes are polygenes/contain hundreds of different alleles;
these have arisen by continued mutation (over millions of years);
alleles from different parts of the gene pool/population are likely to have different effects (in the phenotype); **max 2**

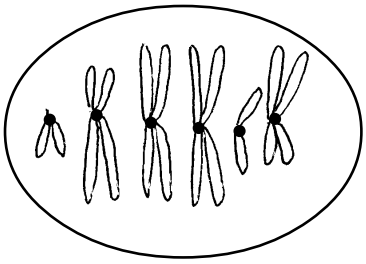
(d) (i) shell size/height/width; **1**

(ii) D;
lines/ridges on the shell; **2**

TOTAL 10

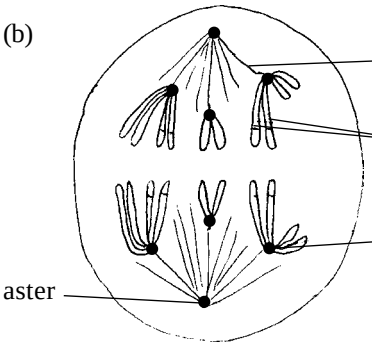
QUESTIONSHEET 10

(a)



6 chromosomes in a row on equator;
same morphology of chromosomes as in metaphase 1 of meiosis diagram;
quality and clarity of diagram;
(chromosomes can be in any order but must not be paired or show chiasmata) **3**

(b)



Any two of the labels (reject chiasmata) - 2 marks;;
chromosomes correctly segregating to poles (in correct order and shape);
spindle and completed chiasmata correctly shown;
quality and clarity of diagram; (clean, well drawn, joined up lines/
no shading /reasonable size) **5**

TOTAL 8

QUESTIONSHEET 11

(a) mitosis maintains the same chromosome number (reject diploid state since mitosis can take place as haploid to haploid)
whereas meiosis halves the chromosome number/reduces the diploid state to the haploid state;
mitosis maintains the same genotype whereas meiosis introduces genetic variation; **2**

(b) random assortment of chromosomes at Anaphase 1;
random assortment of chromatids at Anaphase 2 ;
formation of chiasmata; **3**

(c) best answered by a genetic diagram, eg.

P	Aa × Aa	alleles A and a in each parent; (any letters acceptable)
gametes	Ⓐⓐ ↓ Ⓐⓐ	equal proportions of each gamete;
F_1	AA Aa Aa aa	A is dominant so 3 dominants to 1 recessive; **3**

TOTAL 8

QUESTIONSHEET 12

Feature	Mitosis	Meiosis 1	Meiosis 2	
Occurs during gametogenesis	√	√	√	;
DNA replicates before prophase	√	√	×	;
Bivalents form during prophase	×	√	×	;
Chiasmata are formed	×	√	×	;
Chromatids randomly assort during anaphase	×	×	√	;

do not accept ✓✗

TOTAL 5

(1 mark per correct line)