InkBiology

ANSWER BOOK

Meiosis: two divisions, and why no two gametes come out the same

Inheritance and population genetics · Unit B16

AQA 3.2.2 · OCR A 2.1.6 · Edexcel A Topic 3.10–3.13 · CAIE 16.1

6 questions · 21 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** homologous chromosomes are separated at anaphase I. **B1** sister chromatids are separated at anaphase II, when the centromeres divide. [2]

SECTION B · Standard, 3 to 5 marks

B1 **B1** each chromosome finds its homologue and the two lie alongside each other along their whole length, forming a bivalent of four chromatids. **B1** non-sister chromatids, one maternal and one paternal, break at the same point and each joins to the other's cut end. **B1** the visible point at which they cross is a chiasma, and equivalent sections of DNA have been exchanged. **A1** the two chromatids that took part leave carrying a combination of alleles that neither parental chromosome had, so sister chromatids are no longer genetically identical; the other two leave unchanged. [4]

B2 **B1** crossing over in prophase I exchanges sections of DNA between non-sister chromatids of a homologous pair. **B1** this makes new combinations of alleles along a single chromosome, combinations that were on neither chromosome the cell started with. **B1** independent assortment at metaphase I decides which member of each bivalent faces which pole, and the decision is made separately for every bivalent. **A1** this makes new combinations of whole chromosomes, giving 2 to the power n kinds of gamete where n is the number of homologous pairs. [4]

B3 **M1** halve the diploid number to get the number of homologous pairs, so n = 7, because one decision is made per pair. **A1** 2 to the power 7 is 128 chromosome combinations in a gamete. **M1** a zygote takes one gamete from each parent and the two are independent, so multiply 128 by 128. **A1** 16 384 combinations, and crossing over would make the true figure larger still. [4]

B4 **B1** mitosis is one division producing two daughter cells, whereas meiosis is two divisions producing four. **B1** mitosis leaves the chromosome number unchanged, diploid to diploid, whereas meiosis halves it, diploid to haploid. **B1** homologous chromosomes do not pair in mitosis, whereas in meiosis they pair as bivalents in prophase I and cross over. **B1** the daughters of mitosis are genetically identical to the parent cell, whereas the four products of meiosis all differ from one another. [4]

B5 **B1** no crossing over would occur, so no new combinations of alleles would be made along a chromosome and each chromatid would carry the alleles of the parental chromosome it came from. **B1** sister chromatids would therefore stay genetically identical, so the two cells produced by each meiosis II would be identical to each other. **A1** independent assortment at metaphase I would still combine whole chromosomes in new ways, giving 2 to the power n kinds of gamete, so variation would be reduced rather than abolished. [3]