Unit 1 · Cell Biology

HARDER PRACTICE QUESTIONS

Full marks 50

Write your answers on separate paper. Show your working. Count chromosomes by their centromeres.

1 Spot the error [3]

Rekha was asked: "The garden pea has 2n = 14. How many chromosomes and chromatids are there in one cell at anaphase II?" She wrote:
"Meiosis I has already halved the number, so n = 7. Each chromosome has two chromatids. So the cell has **7 chromosomes and 14 chromatids**."
Find her mistake and give the right numbers.

2 Name the stage from the numbers [5]

A student counted these in cells from one animal. In cell T, neither group holds both chromosomes of any pair.

Cell	Chromosomes	Chromatids	Also seen
P	12	24	6 bivalents on the equator
Q	24	24	two groups moving to the poles
R	6	12	no pairs; a nuclear envelope
S	6	6	one of four small cells
T	12	12	two groups moving to the poles

i. What is 2n for this animal? Give your evidence.
ii. Name the stage or result each cell shows.

3 Read the measurements [4]

The DNA in one cell was followed through a division, from G_1 onward (made-up figures):

Point	1	2	3	4	5	6	7
DNA in each cell (pg)	8	12	16	16	8	8	4

i. Is this mitosis or meiosis? How do you know?
ii. What is 1C for this cell? Which point is the cell partway through S phase?
iii. Asmita says: "The DNA in the cell must fall at anaphase, when the chromatids move apart." Is she right? Explain.

4 What if? [4]

A cell of an onion root tip (2n = 16) has its DNA in G_1 equal to 2C. In this cell the nucleus divides three times, one round after another, with DNA copied before each, but the cytoplasm never divides.

i. How many nuclei does it have at the end?
ii. How many chromosomes in all, and how many in each nucleus?
iii. How much DNA in the whole cell, in terms of C?
iv. Give one real example from the unit of a cell with many nuclei.

5 Estimate it [3]

The bone marrow makes about two million new red blood cells every second.

i. About how many is that in a day? Give your answer in standard form.

ii. The body has between 30 and 37 trillion cells. If one zygote's cells all divided at every round, what is the fewest rounds that would pass 30 trillion?
iii. At 24 hours a round, as for a typical human cell in a dish, how many days is that? A body takes far longer than this to grow. Give one reason.

6 Trace the mistake [5]

In a cell of an animal with 2n = 4, the two chromosomes of **one** pair fail to separate during meiosis.

i. Write the number of chromosomes in each of the four gametes if this happens at anaphase I.
ii. Do the same if it happens instead at anaphase II, in only one of the two cells.
iii. A gamete with the extra chromosome fuses with a normal gamete. How many chromosomes does the zygote have?
iv. Write the numbers for i again for a human cell, and for iii. What is this condition called when the chromosome is number 21?

7 Count the gametes [4]

A fruit fly has 2n = 8. Ignore crossing over.

i. How many kinds of gamete can it make?
ii. What fraction of those kinds carry only chromosomes that came from its father?
iii. How many of those kinds carry exactly one chromosome from its father?
iv. Why is the true number of different gametes far larger than your answer to i?

8 Predict, then explain [3]

Write your prediction first, then explain it.

A chemical stops the spindle fibers from attaching to the kinetochores in a human cell. Predict the stage where the cell stops, and how many chromosomes and chromatids it has there. Explain.

9 Which explanation fits the evidence? [4]

In a trial (made-up figures), 200 potato plants grown from tubers of one plant and 200 grown from seed were each given one strain of blight. The next year, new plants of each kind were given another strain.

Plants that survived	Strain 1	Strain 2
From tubers of one plant	0 of 200	200 of 200
From seed	62 of 200	118 of 200

Birendra: “Plants from seed are simply stronger than plants from tubers.”
Sujata: “Plants from tubers all have the same genes; plants from seed all differ.”
Which explanation does the table support? Use both columns.

10 Design a fair test [4]

Pratiksha reads that root tips for a mitosis slide are cut in the morning. She wonders whether more of the cells are dividing in the morning than in the evening. She has onions, water, and everything needed to make and stain squash slides. Plan a fair test.

i. What will she change, and what will she work out from her counts?
ii. Name three things she must keep the same.
iii. How can she make the result more reliable?
iv. What result would support the idea?

11 Draw and compare [3]

On plain paper, draw a cell with 2n = 4 (one long and one short pair) at **metaphase of mitosis**, at **metaphase I** and at **metaphase II**. Show each chromosome's chromatids and centromere and the spindle fibers. Under each write how the chromosomes sit on the equator.

12 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Rizwan wrote: “Meiosis II halves the chromosome number, because that is when the four cells are made. The DNA is copied again in interkinesis, so that each cell has enough for meiosis II. Crossing over happens between sister chromatids, and this is what makes gametes different.”

13 Think [3]

Ashok says: “Identical twins are clones. A clone has the same genes as its parent, so identical twins must have the same genes as their mother.” What is right in his statement, and what is wrong? Why does an asexual clone differ from twins in this?

14 Make your own [2]

Make up a species with 2n of your choice (from 6 to 20). Write a question with a table of chromosomes, chromatids and DNA at four stages of your choosing, with its answers. Then write how many bivalents it forms and how many kinds of gamete it can make, ignoring crossing over.