When division escapes control

Cells normally divide in response to regulated signals and tissue needs. Loss of normal control can allow excess cells to accumulate as a tumour.

1. THE CAUSAL CHAIN

1 Control is disrupted

Changes in genes controlling the cell cycle can alter cell behaviour.

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2 Division continues inappropriately

Cells reproduce even when the normal controls would restrain them.

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3 Excess cells accumulate

Repeated division can produce an abnormal mass of cells: a tumour.

A tumour grows when cell production exceeds cell loss. This is an increase in the number of cells, not simply one cell swelling.

2. NORMAL MITOSIS IS ESSENTIAL

Controlled cell division supports growth, cell replacement and tissue repair. Mitosis itself is not the problem; the failure to regulate when and how cells proliferate is the problem.

3. A REPEATED PROCESS BUILDS THE MASS

DNA is copied before mitosis and passed to daughter cells. A control-disrupting mutation can therefore be inherited by descendants, allowing the abnormal cell population to expand.

Cell-cycle regulation and mutation: OpenStax Biology 2e, sections 10.3-10.4.
Cell accumulation and tumours: NCI SEER, What Is Cancer?

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 6, p. 23.

What normally restrains division?

Supporting explanation: cell-cycle control coordinates growth, DNA copying and division. Mutations can disrupt the proteins that carry out this regulation.

1. RESPOND TO APPROPRIATE SIGNALS

Normal proliferation depends on conditions such as growth signals, nutrient availability and interactions with surrounding cells. Dividing continuously is not the default requirement of every cell.

2. CHECK BEFORE PROCEEDING

Checkpoints can delay cell-cycle progression when conditions are unsuitable or DNA is damaged. This provides opportunities for repair. If damage cannot be resolved, a cell may stop dividing or undergo programmed cell death.

3. MUTATIONS CAN DISTURB THE BALANCE

TOO MUCH STIMULATION

Changes can make proteins that promote division overactive.

TOO LITTLE RESTRAINT

Changes can reduce the activity of proteins that slow or stop division.

The result can be inappropriate progression through the cell cycle, rather than a coordinated response to the needs of the tissue.

4. A MUTATION DOES NOT AUTOMATICALLY MEAN CANCER

Many DNA changes do not cause uncontrolled proliferation. Cancer usually develops through an accumulation of relevant changes, not because every mutation instantly creates a cancer cell.

Signals and checkpoints: OpenStax Biology 2e, section 10.3.
Loss of regulation: OpenStax Biology 2e, section 10.4.

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 6, p. 23.

A tumour is not always cancer

Supporting distinction: benign and malignant tumours both involve abnormal cell accumulation, but they differ in invasion and the ability to spread.

1. COMPARE BEHAVIOUR, NOT JUST SIZE

BENIGN

Not cancerous

Does not invade nearby tissues.

Does not metastasise

Does not form distant secondary tumours.

Can still cause harm

May press on important structures.

MALIGNANT

Cancerous

Invades surrounding tissues.

Can metastasise

Cells may spread and establish tumours elsewhere.

Disrupts normal tissues

Invasion and growth can impair function.

2. WHY TISSUE FUNCTION CAN SUFFER

An enlarging mass can compress adjacent structures. Malignant cells can also invade and damage surrounding tissue. The consequences depend on the tumour's location and behaviour, not only its size.

3. AVOID TWO SHORTCUTS

Rapid cell division can occur in normal growth or repair, so speed alone does not define cancer. Also, some cancers, such as leukaemias, generally do not form a solid tumour.

Core connection: loss of cell-cycle control allows repeated, inappropriate division; excess cells accumulate and can form a tumour.

Benign tumours and tissue effects: NCI SEER, What Is Cancer?
Invasion, metastasis and blood cancers: NCI, What Is Cancer?

Scope: Cambridge Biology 9700 syllabus, section 5.1, outcome 6, p. 23.