Loss of Normal Growth Control

Normal cell division

Cell damage—no repair

Cell Suicide or Apoptosis

Cancer cell division

First mutation
Second mutation
Third mutation
Fourth or later mutation

Uncontrolled growth
# Microscopic Appearance of Cancer Cells

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<thead>
<tr>
<th>Normal</th>
<th>Cancer</th>
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- **Large number of irregularly shaped dividing cells**
- **Large, variably shaped nuclei**
- **Small cytoplasmic volume relative to nuclei**
- **Variation in cell size and shape**
- **Loss of normal specialized cell features**
- **Disorganized arrangement of cells**
- **Poorly defined tumor boundary**
Tobacco Use and Cancer

Some Cancer-Causing Chemicals in Tobacco Smoke

- aminostilbene
- arsenic
- benz[a]anthracene
- benz[a]pyrene
- benzene
- benzo[b]fluoranthene
- benzo[c]phenanthrene
- cadmium
- chrysene
- dibenz[a c]anthracene
- dibenzo[a e]fluoranthene
- dibenz[a h]acridine
- dibenz[a j]acridine
- dibenzo[c g]carbazone
- N-dibutylnitrosamine
- 2,3-dimethylchrysene
- indeno[1,2,3-c d]pyrene
- S-methylchrysene
- S-methylfluoranthene
- alpha-naphthylamine
- nickel compounds
- N-nitrosodimethylamine
- N-nitrosomethylmethyamine
- N-nitrosodiethylamine
- N-nitrosonornicotine
- N-nitrosoanabasine
- N-nitrosopiperidine
- polonium-210

DNA Mutation

- **Normal gene**: CAAGCTAACT
- **Single base change**: CAAGCGAACCT
- **Additions**: CAAGCCCTAACT
- **Deletions**: CAAGAAACT
Oncogenes

Normal genes regulate cell growth

Oncogenes accelerate cell growth and division

Normal cell

Cancer cell

Mutated/damaged oncogene
Tumor Suppressor Genes

Normal genes prevent cancer

Damage to both genes leads to cancer

Normal cell

Remove or inactivate tumor suppressor genes

Cancer cell

Mutated/inactivated tumor suppressor genes
DNA Repair Genes

Normal DNA repair

Base pair mismatch

TCCTAC
AGCTG

TCGAC
AGCTG

No cancer

TCCTAC
AGCTG

TCCTAC
AGATG

Cancer

No DNA repair
Cancer Tends to Involve Multiple Mutations

Benign tumor cells grow only locally and cannot spread by invasion or metastasis.

Malignant cells invade neighboring tissues, enter blood vessels, and metastasize to different sites.

Time

Mutation inactivates suppressor gene

Cells proliferate

Mutations inactivate DNA repair genes

Proto-oncogenes mutate to oncogenes

More mutations, more genetic instability, metastatic disease