Previous Class

- Model human organisms
  - Have homology in genes
  - Obesity model – mice
  - Developmental model – *C. elegans*
- Biomarkers
  - Chromosomal abnormalities
    - Downs Syndrome (trisomy 21)
    - Karyotyping
    - FISH
  - Mutations of specific genes
    - RFLP (Restriction Fragment Length Polymorphism)
    - AOS (Allele Specific Oligonucleotide Analysis)
  - SNPs (Single Nucleotide Polymorphisms)
  - DNA microarrays

Medical Products and Applications of Biotechnology

- Identifying novel drugs and developing new ways to treat disease
  - **Oncogenes** – genes involved in the growth of cancer cells
    - They produce proteins that may act as transcription factors and receptors for hormones and growth factors
    - They also serve as enzymes which alter growth properties of cancer-causing cells
  - **Tumor suppressor genes** – produce proteins that keep cancer formation in check
  - Small molecule inhibitors – drugs
  - “Activators” binding can stimulate proteins to fight disease

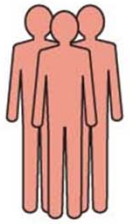
- **Pharmacogenomics** – Customized Medicine
  - Designing the most effective drug therapy and treatment strategies based on the specific genetic profile of a patient
  - Individuals can react differently to the same drugs
    - Different degrees of effectiveness and side effects because of genetic polymorphisms

Pharmacogenomics

Individuals respond differently to the anti-leukemia drug 6-mercaptopurine.

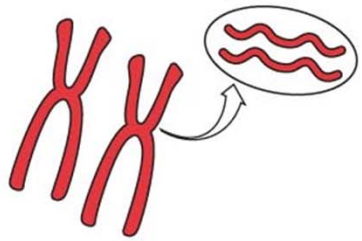
Most people metabolize the drug quickly. Doses need to be high enough to treat leukemia and prevent relapses.

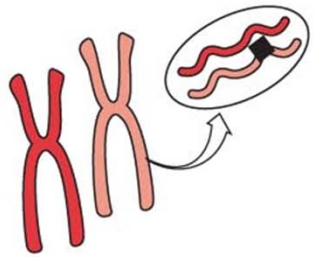
Others metabolize the drug slowly and need lower doses to avoid toxic side effects of the drug.

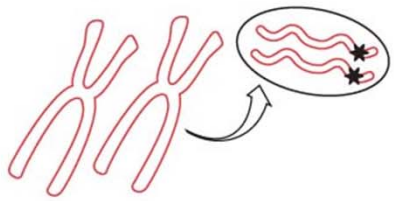


A small portion of people metabollize the drug so poorly that its effects can be fatal.

The diversity in responses is due to variations (mutations, ■ or ✱) in the gene for an enzyme called TPMT, or thiopurine methyltransferase.

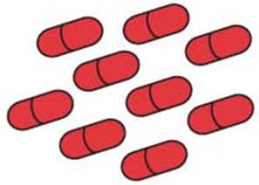




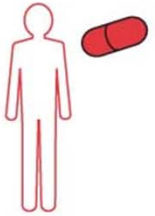


After a simple blood test, individuals can be given doses of medication that are tailored to their genetic profile.

Normal dose

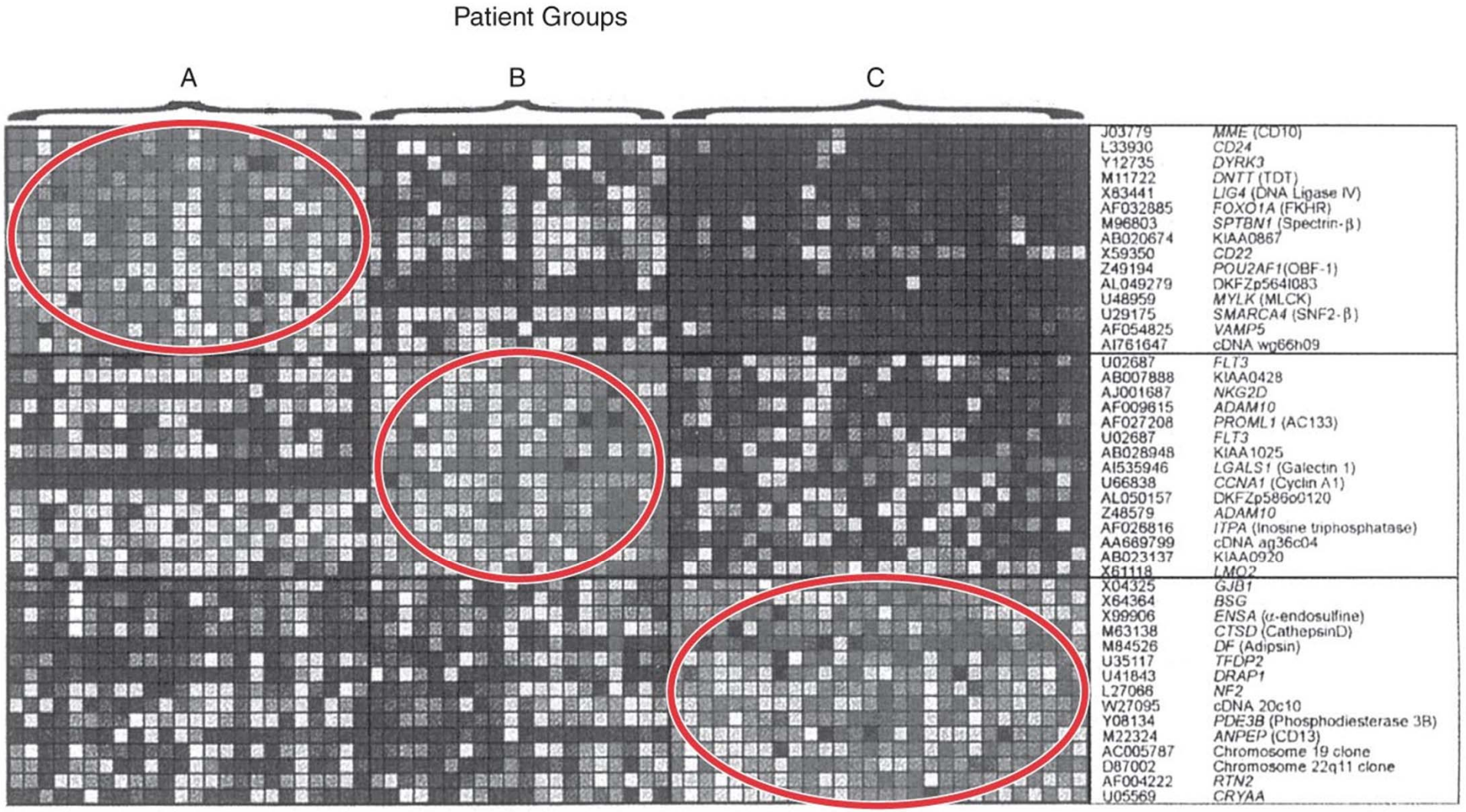


Dose for an extra slow metabolizer (TPMT deficient)



- Chemotherapy drugs target rapidly dividing cells, so they kill cancer cells
- But normal cells such as hair and skin cells and cells in bone marrow are also killed
- This leads to hair loss, dry skin, changes in blood count, nausea etc.
- Specific drugs that target only cancer cells don’t exist

Microarray for Leukemia screening



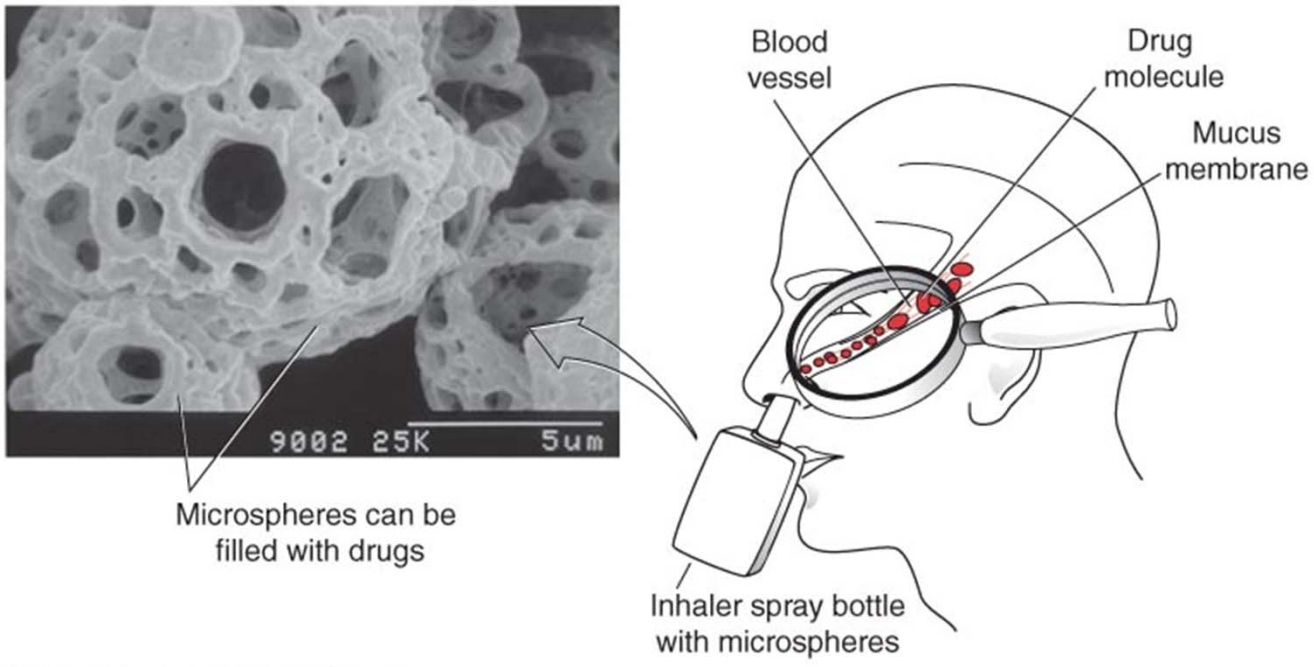
- Improved Drug Delivery
  - Maximize drug effectiveness
    - Drug solubility, drug breakdown, drug elimination
  - Getting drug to target organs and tissue
    - Oral drug to treat arthritis in knee is not very efficient
    - Drug solubility may be an issue

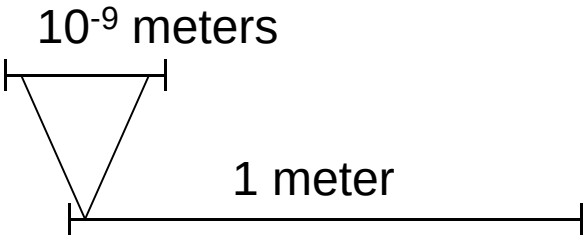
Drug delivery

- **Microspheres** – tiny particles that can be filled with drugs
  - Made from materials that closely resemble lipids found in cell membranes
  - Mist sprayed in the nose to treat lung cancer and other respiratory illnesses; anticancer drugs; anesthetics for pain management

Used to treat asthama, Tb and Flu

Insulin delivered as a powder through an inhaler

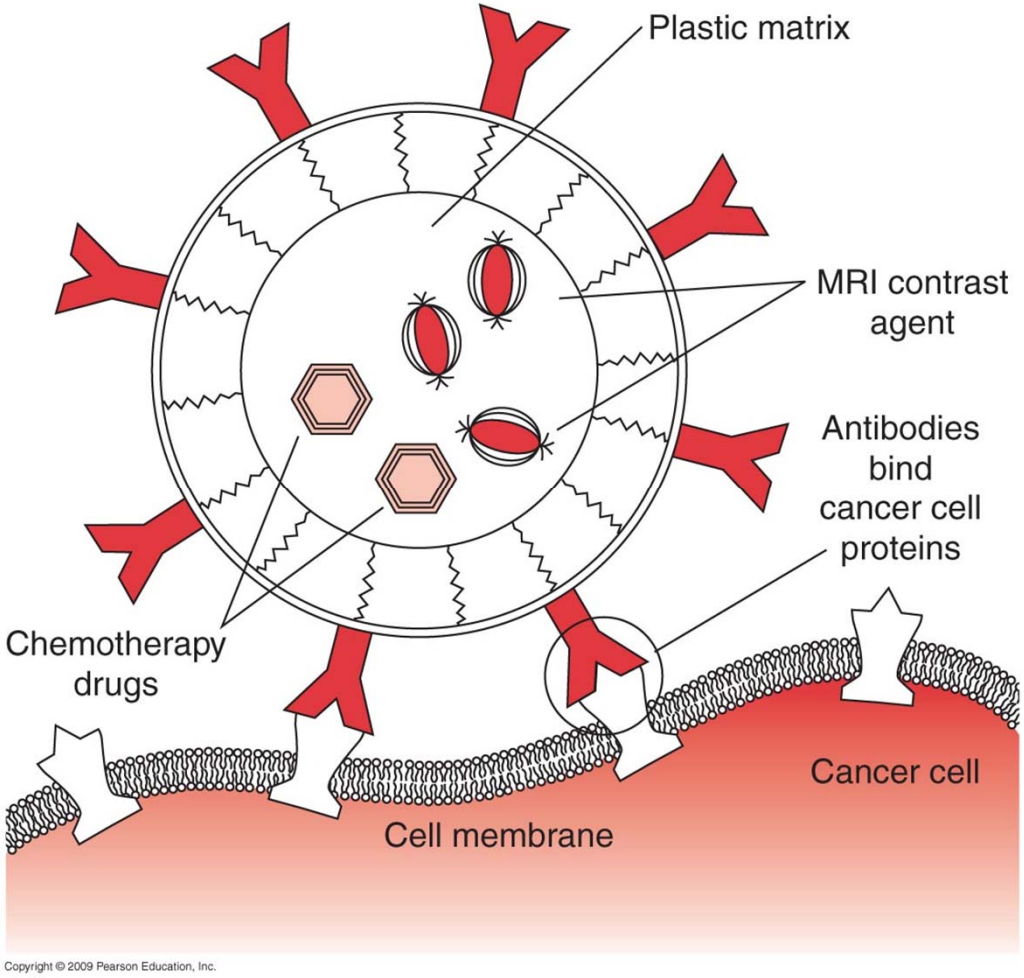




- Nanotechnology and Nanomedicine
  - **Nanotechnology** – involved in designing, building, and manipulating structures at the nanometer scale
    - nm is 1 billionth of a meter
  - **Nanomedicine** – applications of nanotechnology to improve human health
    - Nanodevices to monitor blood pressure, blood oxygen levels, hormone concentrations
    - Nanoparticles that can unclog arteries, detect and eliminate cancer cells; smart drugs that could seek out and target specific cells

Nanomedicine

- **Tumor seeking and tumor killing nanoparticles**
- Antibodies against cancer cells proteins allow binding of nanoparticle to cancer cells
- Contrast agents for MRI and X-ray can be used to detect tumor
- Chemotherapy drugs can diffuse out to kill cancer cells



Artificial blood

- Cell-free solutions containing molecules that can bind and transport oxygen like hemoglobin
- Benefits
  - Disease-free alternative to real blood
  - Constant supply
  - Universal donor type
- Disadvantages
  - Cannot perform all the functions of a red blood cell-only oxygen delivery
    - Source of iron
    - Carbon dioxide removal

- Vaccines and Therapeutic Antibodies
  - Cancer vaccines – injected with cancer cell antigens to stimulate immune system to attack cancer cells
  - Vaccine for Alzheimer's disease
- Monoclonal Antibodies – purified antibodies that are very specific for certain molecules
  - Cancer cells, arthritis, and Alzheimer's Disease
  - Treat addiction to harmful drugs

Making Monoclonal Antibodies