The Basis of Genetics
The Cell Cycle
Cell Signaling
Angiogenesis and Lymphangiogenesis
Metastasis
The Role of the Immune System in Cancer
Estimated Percentage of Cancer Deaths Attributable to Established Risk Factors

- Tobacco: 30%
- Adult Diet/Obesity: 30%
- Sedentary Lifestyle: 5%
- Alcohol: 3%
- Salt/Other Food Additives/Contaminants: 1%
- Ionizing/Ultraviolet Radiation: 2%
- Occupational Factors: 5%
- Viruses/Other Biologic Events: 5%
- Family History of Cancer: 5%
- Perinatal Factors/Growth: 5%
- Reproductive Factors: 3%
- Socioeconomic Status: 3%
- Environmental Pollution: 2%
- Prescription Drugs/Medical Procedures: 1%
Cancers Due to Five Infections Correspond to 18% of Global Cancer Incidence

- Epstein Barr virus (EBV) 10.3%
- Helicobacter pylori 10.3%
- Human Papillomavirus (HPV) 27.9%
- Hepatitis B virus (HBV) and Hepatitis C virus (HCV) 24.8%
Colorectal Intraepithelial Neoplasia (IEN)
Imaging Modalities for Diagnosis and Imaging Response to Therapy
The Cancer Genome Atlas (TCGA)
Biomarkers Are the Foundation of Personalized Medicine
Drug Discovery and Development Timeline

- **Pre-Discovery**: 3 – 6 years, ~5,000 – 10,000 compounds
- **Drug Discovery**: 250
- **Preclinical**: 5
- **Clinical Trials**: Phase 1 (20-100 volunteers, 6 – 7 years), Phase 2 (100–500 volunteers), Phase 3 (1,000–5,000 volunteers)
- **FDA Review**: 0.5 – 2 years
- **Scale-Up to Mfg.**: Indefinite
- **Post-Marketing Surveillance**: Indefinite

One FDA-Approved Drug
Development of Imatinib (Gleevec)
Receptor Tyrosine Kinase Cell Signaling
Drug Resistance
Genetically Informed Clinical Trials

Traditional Trial

1 box = 10 random patients
Phase II 60 patients
Phase III 3,000 patients

Personalized Trial

1 box = 10 genetically screened patients paired to potential drug
Phase II 60 DNA patients/drug
Partial confirmation
Phase III 300 patients/drug
Cancer Occurs and Can Be Treated at Every Scale
The Public and Private Sectors Play Different Roles in Research
Lifetime Cancer Incidence

1 out of 2 men and 1 out of 3 women will be diagnosed with cancer in their lifetimes.
The Costs of Cancer - 2010

The National Institutes of Health estimated the 2010 overall annual costs of cancer were as follows:

**Total Cost:** $263.8 Billion

- **Direct Medical Costs** (total of all health expenditures): $102.8 Billion
- **Indirect Morbidity Costs** (cost of lost productivity due to illness): $20.9 Billion
- **Indirect Mortality Costs** (cost of lost productivity due to premature death): $140.1 Billion

Source: ACS
Clinical Trial Participation
Global Collaboration and Multidisciplinary Teams
Biomedical Research and Development Price Index (BRDPI)
National Research and Development Investment (Percent of GDP)