chromosome will be the sole chromosome from one parent, resulting in a cell with two chromosomes from the same parent. UPD is sometimes associated with clinical abnormalities, and this can occur by two mechanisms. UPD can cause disease when there is an imprinted gene on the involved chromosome, resulting in altered gene expression. Imprinting is the chemical marking of the parental origin of a chromosome, and genes that are imprinted are only expressed from either the maternal or paternal chromosome **(Chap. 82)**. Imprinting therefore results in the differential expression of affected genes, based on parent of origin. Imprinting usually occurs through differential modification of the chromosome from one of the parents, and methylation is one of several epigenetic mechanisms (others include histone acetylation, ubiquitylation, and phosphorylation). Imprinted chromosomes that are associated with phenotypes include paternal UPD6 (associated with neonatal diabetes), maternal UPD7 and UPD11 (associated with Russell-Silver syndrome), paternal UPD11 (associated with Beckwith-Wiedemann syndrome), paternal UPD14, maternal UPD15 (Angelman syndrome), and paternal UPD15 (Prader-Willi syndrome). UPD can also result in disease if the two copies from the same parent are the same chromosome (uniparental isodisomy), and the chromosome contains an allele involving a pathogenic mutation associated with a recessive disorder. Two copies of the deleterious allele would result in the associated disease, even though only one parent is a disease carrier.

ACQUIRED CHROMOSOME ABNORMALITIES IN CANCER

Chromosome changes can occur during meiosis or mitosis and can occur at any point across the lifespan. Mosaicism for a developmental disorder is one consequence of mitotic chromosome abnormalities, and another consequence is cancer, when the chromosome change confers a growth or proliferation advantage on the cell. The types of chromosome abnormalities seen in cancer are similar to those seen in the developmental disorders (e.g., aneuploidy, deletion, duplication, translocation, isochromosomes, rings, inversion). Tumor cells often have multiple chromosome changes, some of which happen early in the development of a tumor, and may contribute to its selective advantage, whereas others are secondary effects of the deregulation that characterizes many tumors. Chromosome changes in cancer have been studied extensively and have been shown to provide important diagnostic, classification, and prognostic information. The identification of cancer type–specific translocation breakpoints has led to the identification of a number of cancer-associated genes. For example, the small abnormal chromosome found to be associated with chronic myelogenous leukemia (CML) in 1960 was shown to be the result of translocation between chromosomes 9 and 22 once techniques for analysis of banded chromosomes were introduced, and subsequently, the translocation breakpoint was cloned to reveal the *c-abl* oncogene on chromosome 9. This translocation produces a fusion protein, which has been targeted for treatment of CML. **For detailed discussion of cancer genetics, see Chap. 101e.**