**Chapter 6**

**DNA Detective  
Complex Patterns of Inheritance,   
and DNA Fingerprinting**

**Extensions of Mendelian Genetics**

* **Incomplete Dominance** is when a heterozygote expresses a phenotype intermediate between both alleles.
  + For example, *RR* produces red flowers, *Rr* produces pink flowers and *rr* produces white flowers
* **Codominance** is when two alleles are expressed at the same time.
  + ABO blood type is an example of this with both the dominant A and B being expressed in a type AB person.
* **Multiple allelism** occurs when there are more than two alleles of a gene.
  + ABO blood types exhibit this.
* **ABO** blood group has three alleles of one gene:
  + *IA* and *IB* are codominant to each other; *i* is recessive to both other alleles.
  + An individual will have two of these alleles.
  + Another blood group is called the **Rh factor.**
  + Rh+ is caused by a dominant allele.
    - Rh+Rh+ or Rh+Rh-
  + Rh- is caused by 2 recessive alleles.
    - Rh-Rh-
  + **Blood typing** can be used to exclude potential parents.
* **Pleiotropy** is the ability of a single gene to cause multiple effects on the individual’s phenotype.
* **Hemophilia** is an example of pleiotropy.
  + The inability to clot blood normally due to the absence of a clotting factor
  + Gene for this clotting factor is on the X chromosome

**Sex Determination and Sex Linkage**

* Humans have 22 pairs of **autosomes** and one pair of **sex chromosomes**
  + Women: two X chromosomes
  + Men: one X and one Y chromosome
* **Sex-linked genes**: genes located on the sex chromosomes
  + **X-linked**: located on the X chromosome
  + **Y-linked**: located on the Y chromosome
    - SRY gene which leads to the development of the testes
* Males always inherit their X from their mother
* Males are more likely to express recessive X-linked traits than females due to carrying only 1 X.
* Females are less likely to express X-linked traits since they have to have 2 copies of the bad X’s.
* Only females can be **carriers** of X-linked recessive traits.
* Carriers express the normal trait but are heterozygous, so they carry the allele for the recessive trait.
* Hemophilia, red-green color blindness, and Duchenne Muscular dystrophy are example of X-linked traits.
* **X inactivation** guarantees that all females receive only 1 dose of the proteins by the X chromosomes.
* Inactivation is irreversible and inherited during cell division.
* It is caused by RNA wrapping around the X chromosome.

**Pedigrees**

* **Pedigree**: a family tree, showing the inheritance of traits through several generations
* Symbols commonly used in pedigrees are circles and squares
* Pedigrees reveal modes of inheritance
* Pedigree for an **autosomal dominant** trait:

**DNA Fingerprinting**

* No two individuals are genetically identical except for identical twins.
  + Small differences in nucleotide sequences of their DNA
* This is the basis for DNA fingerprinting
  + Unambiguous identification of people
  + When sample size is small it is necessary to copy the genetic material to increase the quantity available for testing.
* Small amounts of DNA can be amplified using **PCR (polymerase chain reaction)**
* DNA is mixed with nucleotides, specific **primers**, ***Taq* polymerase**, and then is heated
* Heating splits the DNA molecules into two complementary strands
* *Taq* polymerase builds a new complementary strand
* DNA is heated again, splitting the DNA and starting a new cycle.
* DNA is cut into fragments using **restriction enzymes**, which cut around DNA sequences called **VNTRs (variable number tandem repeats).**
* [**Gel electrophoresis**](08_gel_electrophoresis.swf) separates DNA fragments on basis of their sizes
  + Electric current is applied to an **agarose gel**
  + Smaller fragments run faster through the gel
* Fragments are transferred to a sheet of filter paper
* Labeled **probe** reveals locations of fragments containing VNTRs
* Each person’s set of fragments is unique.
* All of a child’s bands must be present in one or both of the parents.
* To see if parents and their children were Romanovs, DNA fingerprints were prepared for relatives of tsar and tsarina.
* Adult male skeleton (related to the children) was related to George, the tsar’s brother.
* Adult female skeleton (related to the children) was related to Prince Philip, the tsarina’s grand-nephew.
* **Conclusion**: the grave contained the tsar, tsarina, three of their children, and four servants.