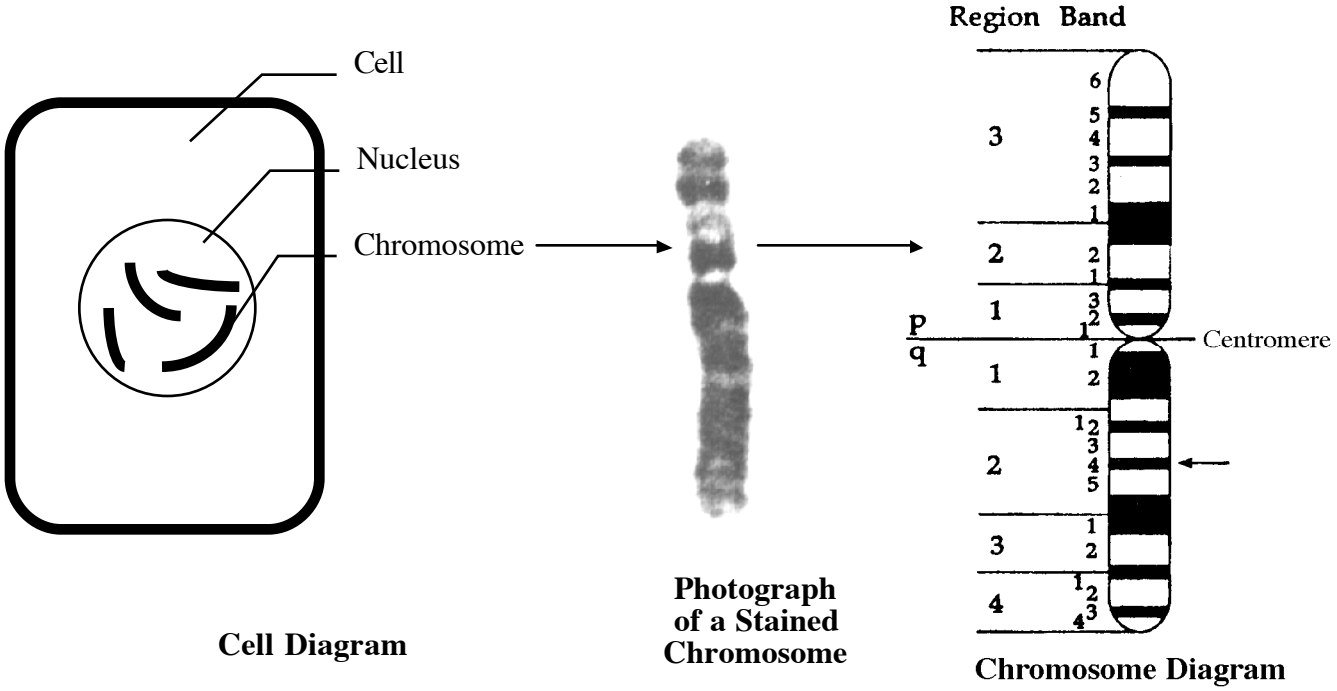
THE CHROMOSOME CONNECTION 2
BACKGROUND INFORMATION

A. <u>THE BIG IDEA</u>: The degree of chromosome pattern similarity between two species indicates the degree of biological relationship.

B. <u>BACKGROUND</u>:

Chromosomes are microscopic strands found in the nuclei of the cells of most living things. Each chromosome consists mainly of a single **DNA molecule**, whose coded sequences (**genes**) determine that organism's **characteristics**. In other words, the genes for the characteristics of an organism are located IN that organism's chromosomes. Similarities of the characteristics in the members of one species (humans for example) are due to the similarities in the information (DNA sequences) in their chromosomes.

To extend that logic, wouldn't similarities between members of **different species** also be due to the similarities in the information in their chromosomes? Comparing chromosomes is one of the several ways we can assess the evolutionary relationships between organisms of different species. Organisms get their chromosomes from their parents, and even further back in time, from their ancestors. If evolution has occurred, we would expect that two species having a recent common ancestor should have chromosomes that are more similar than two species having a more distant common ancestor. In other words, **species that are closely related should have very similar chromosomes.**



Cell Diagram | **Photograph of a Stained Chromosome** | **Chromosome Diagram**

Chromosomes are usually prepared for viewing by squashing some of the organism's cells so their nuclei burst and release their contained chromosomes. These are then stained, and photographed through a microscope. Chromosomes are nearly impossible to see, much less distinguish, without adding a stain. A number of different stains can be used, but certain ones reveal characteristic banding patterns. When Giemsa stain is used, the **bands** produced are called G-bands. With Giemsa stain, regions where the chromosome proteins (histones) are **tightly packed** appear **dark**, while regions with less condensed proteins appear lighter.

Even with staining, photographs of the chromosomes still appear fuzzy, so scientists apply techniques to make the banding appear more distinct, observe many chromosomes, and develop **chromosome diagrams**, as shown above. NOTE: these bands are NOT genes; there may be hundreds of genes in a single band.

In addition, some studies use chromosomes taken from the metaphase stage (where chromosomes are seen as fairly short); other studies consider the chromosomes during their late prophase, when they are much longer, and show many more bands (appearing somewhat different from their metaphase versions). This enables a more detailed analysis. The chromosomes used in this activity came from a published study by Yunis, et al (1982) using the late prophase stage, showing about 1000 bands for the whole set.

C. **SUMMARY:**

Chromosome similarity implies biological relationship:

a. Numerous studies show that **chromosome similarity** is a good measure of **genetic relatedness**. The visible structure of chromosomes is an extremely complex pattern of bands and lines. The probability that two different chromosomes would independently have identical banding patterns by chance is essentially zero (Wallace, 1966).

b. Detailed studies provide clear evidence that any **identical chromosomes** in two different species **indicates common ancestry** just as surely as identical scratch patterns on two bullets indicate that both came from the same gun (Wallace, 1966).

D. ACTIVITIES AND QUESTIONS

At this point, go to the **Activity Packet** provided and follow the directions found there. You or your team will also receive an **envelope** with 7 cutout pieces to use with the Activity Packet. At various points, answer the **Check Questions** to see if you have understood the concepts presented up to that point. Your teacher may ask that you number and record all answers on a separate sheet to hand in, and not mark on the packet.

When comparing chromosomes from different species, only one member of each pair of matching chromosomes is used (plus an X and a Y), since both members of each pair appear identical (except for the XY combination in males). In examining the chromosomes, the **length** of the chromosome, the location of the **centromere** (usually constricted, where spindle fibers attach) and the **banding patterns** are studied very closely. The similarities and differences are carefully noted.

Be sure to return all 7 pieces to the envelope when finished.

E. RESOURCES:

Wallace, B. 1966. *Chromosomes, Giant Molecules, and Evolution*. New York: W.W. Norton & Co., Ch.2.

Yunis, J.J. and O. Prakash, 1982. "The origin of man: A chromosomal pictorial legacy". *Science*, 215, 1525-1529.