Topic 3.2

Chromosomes
Chromosomes in Prokaryotes

• 1 single, circular chromosome

• Reproduce by binary fission (asexually—can “conjugate” but that is not considered sexual reproduction

• In sexual reproduction, have two parents, so chromosomes are paired (homologues)

• Prokaryotes only have one parent, so only one chromosome
Some Prokaryotes have Plasmids

- Small loops of DNA
- Extra copies of SOME of the genetic info
- Found in some Archaea and Eubacteria
- Replicate independently, can have several plasmid copies per cell
- Used in genetic engineering
Eubacteria

- Cell Walls of Peptoglycenc
- Cannot survive in as extreme environments
- More standard energy production

Archaebacteria

- Live in extreme environments
- Cell walls made of different matter
- Less standard energy production

No nucleus
- No organelles
- Single Celled

Prokaryotes
- Evolved from a common ancestor
Eukaryotic chromosomes associated with histone proteins that form nucleosomes

Wrapping or packaging of DNA REGULATES transcription process (one type of regulation)
Prokaryotic chromosomes have DNA folding factor proteins that form loop domains.

Eukaryote Chromosomes

- Linear DNA
- At least one PAIR of chromosomes (usually more)
- Two copies of each gene (and alleles)
- No so easily used in genetic engineering—other techniques are required that we will cover later
<table>
<thead>
<tr>
<th></th>
<th><strong>Prokaryote</strong></th>
<th><strong>Eukaryote</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of chromosomes</strong></td>
<td>1</td>
<td>2 or more (*Except male bees, wasps, ants)</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Circular</td>
<td>Linear</td>
</tr>
<tr>
<td><strong>Histones</strong></td>
<td>Not present (Except in Archaean DNA) (Bacteria have DNA Factor proteins)</td>
<td>Present</td>
</tr>
<tr>
<td><strong>Presence of Plasmids</strong></td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td><strong>Organized into Pairs</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Eukaryotes

Homologous Chromosomes

• Homologous = similar in shape & size

• Means that the two chromosomes carry the same genes

• Not identical because the alleles for the genes from each parent could be different
Homologous Chromosomes

Two Pairs of Homologous Chromosomes

Allele A

Allele a

The arrows point to corresponding genes.
Eukaryotes

Diploid vs. Haploid Cells

• Diploid = cells that have two copies of each chromosome (one homologous chromosome from each parent) = $2n$

• Somatic (body) cells – most cells

• Sex cells - gametes are HAPLOID ($n$) – one copy of chromosome

• Humans $n = 23$ (gametes), $2n = 46$
Diploid vs. Haploid Cells

Haploid (N)

Diploid (2N)
Diploid Cells (2n)

Haploid Cells (n)
Chromosome # - A Defining Feature

• Generally the # of chromosomes = a diagnostic feature of a species (in combination with other traits) unless there is an abnormality (trisomy, abnormal #)

• Humans \( n = 23 \) (gametes), \( 2n = 46 \)
• Chimpanzee \( n = 24 \), \( 2n = 48 \)
• Rice \( n = 12 \), \( 2n = 24 \)
• Roundworm \( n = 1 \), \( 2n = 2 \)
<table>
<thead>
<tr>
<th>Organism</th>
<th>Number of chromosomes</th>
</tr>
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<tbody>
<tr>
<td>pea plant</td>
<td>14</td>
</tr>
<tr>
<td>sun flower</td>
<td>34</td>
</tr>
<tr>
<td>cat</td>
<td>38</td>
</tr>
<tr>
<td>puffer fish</td>
<td>42</td>
</tr>
<tr>
<td>human</td>
<td>46</td>
</tr>
<tr>
<td>dog</td>
<td>78</td>
</tr>
</tbody>
</table>

**Chromosome #**

**A Defining Feature**
Karyograms & Karyotypes

KARYOGRAM = representation of the chromosomes found in a cell arranged according to a standard format (usually large to small, then by centromere location)

KARYOTYPE = the specific # and appearance of the chromosomes in one individual’s cells

QUESTION: Do all human karyotypes look alike?
Sex Determination

• 23rd chromosomes in humans determine sex

• AUTOSOME = Any chromosome that is not a sex chromosome

• AUTOSOMAL = occurring on any chromosome that is not a sex chromosome

• SEX LINKED \rightarrow \text{ refers to alleles that are located on sex chromosome - \# 23 in humans}
Autosomes

Sex Chromosomes

Human Karyotype

1  2  3  4  5
6  7  8  9  10  11  12
13 14 15 16 17 18 19
20 21 22

Female

Male
Autoradiography

• Chromosome or DNA fragments labeled with radiactive material (RADIO MARKERS)

• Image/Radiograph created by radioactive particles being emitted from the “marked” DNA

• In 1962 this technique used by John Cairns to show:
  • Bacteria is made up of 1 circular strand of DNA
  • That the DNA is unzipped for replication
Autoradiography

(A) 

(B) 

Daughter strand

Replication fork

Parent strand

100 μm