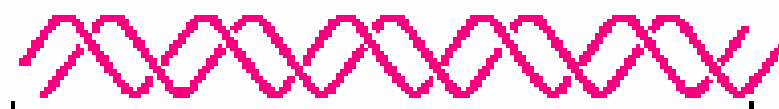


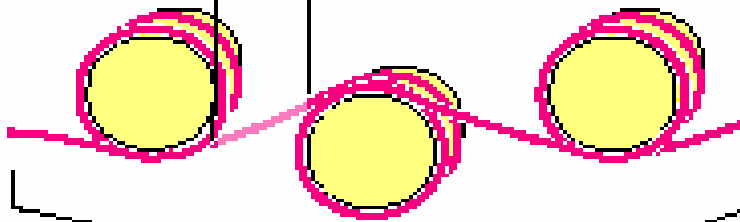
Chromosome

short region of DNA double helix



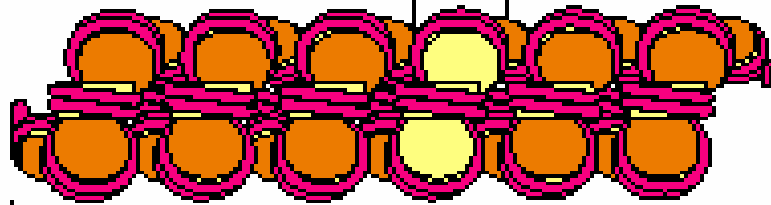
2 nm

"beads-on-a-string" form of chromatin



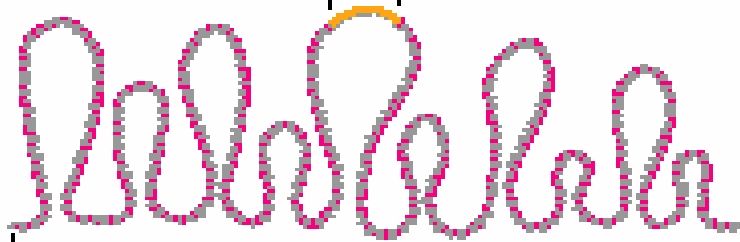
11 nm

30-nm chromatin fiber of packed nucleosomes



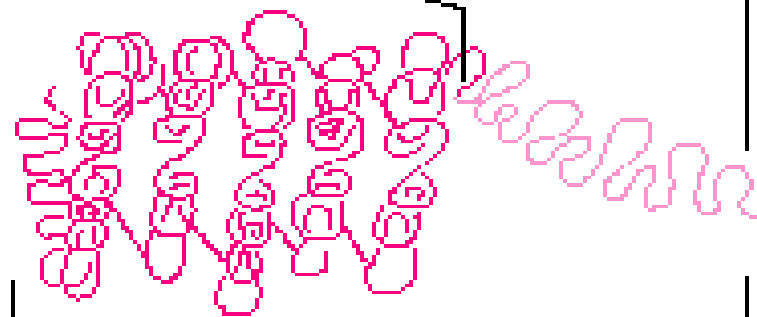
30 nm

section of chromosome in an extended form



300 nm

condensed section of chromosome



700 nm

entire mitotic chromosome



1400 nm

NET RESULT: EACH DNA MOLECULE HAS BEEN PACKAGED INTO A MITOTIC CHROMOSOME THAT IS 50,000x SHORTER THAN ITS EXTENDED LENGTH

**Organization of DNA into Chromosomes
allows for orderly process of nuclear
functions such as**

Molecular Level {

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Molecular Level { DNA transcription
DNA replication
DNA repair
etc.

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Cellular Level {

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Molecular Level { DNA transcription
DNA replication
DNA repair
etc.

Cellular Level { Nuclear vs. Cytoplasmic organization
Chromosome duplication
Chromosome separation
Cell Division
etc.

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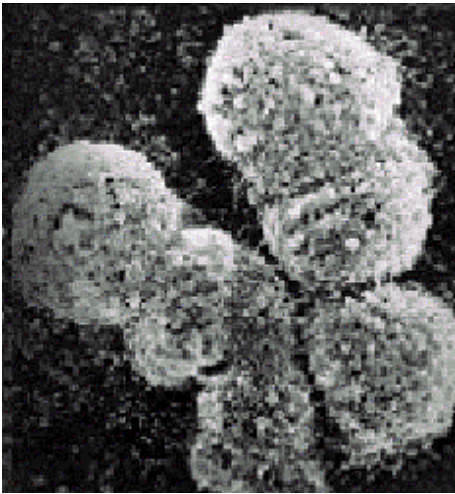
| | |
|------------------|---|
| Molecular Level | { DNA transcription DNA replication DNA repair etc. |
| Cellular Level | { Nuclear vs. Cytoplasmic organization Chromosome duplication Chromosome separation Cell Division etc. |
| Organizmal Level | { Reproduction Evolution Polyploidization etc. |

Cytogenetics = The study of
chromosome number, structure,
function, and behavior in relation to
gene inheritance, organization and
expression

Chromosome

Chromo = colored in response to dye

Some = body



Chromosome of Eukaryotes have been the traditional subject for cytogenetic analysis because they are large enough to be examined with light microscope

History of cytogenetics

~1600 Janssen & Janssen, father & son lay claim to the invention of the compound microscope



Soon after cellular structure of plants and animals were recognized



Significant improvements in glass quality & lens manufacturing lead to

Recognition of separate organelles within cells



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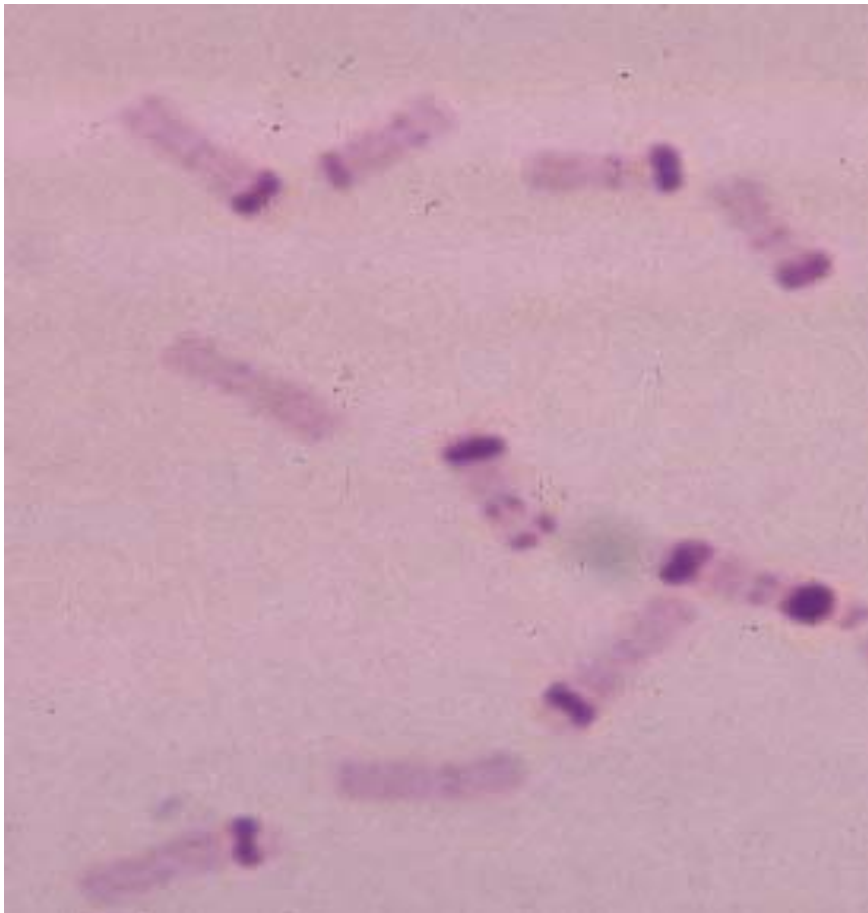
Lineage theory: Cells are derived from pre-existing cells (i.e. all cells trace back to one original cell)





End of 19th century

- Mitotic and meiotic cell division & sexual reproduction had been described
- Chromosomes had also been observed consistency of appearance suggested an important basic function





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Early 1900: Age of Genetics

Mandel's Laws are re-discovered

Genes are the basic unit of inheritance

- Alleles are different forms of the same gene that segregate during gamete formation (Law of Segregation)
- Alleles of different genes segregate independently (Law of independent assortment)





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Chromosome theory of heredity:

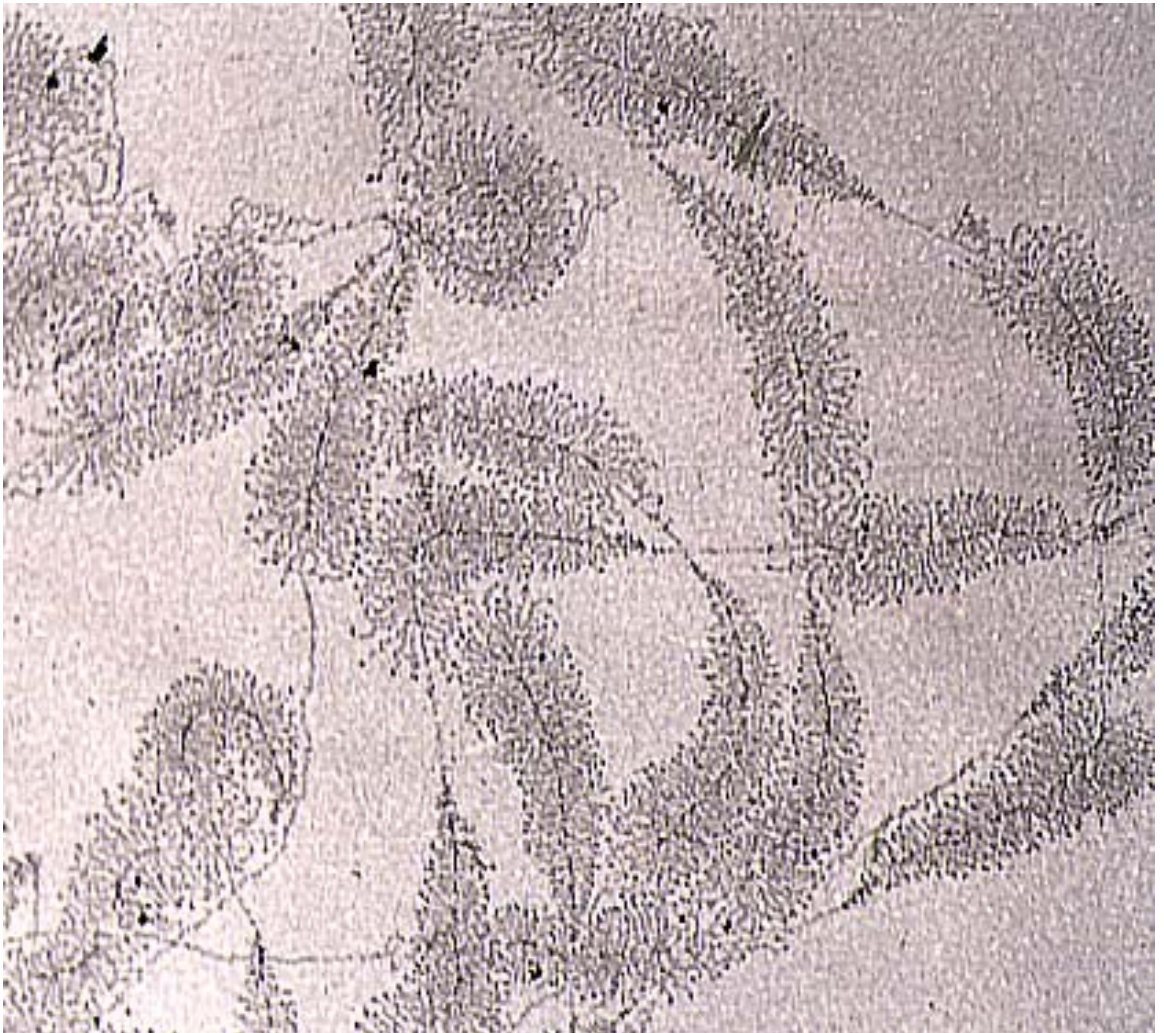
Heredity characters are carried & passed on to generations in discrete units (Correlation between Mendelian inheritance and chromosome behavior)





1920s and 1930s

- Natural or irradiation induced alterations in chromosome number and structure were observed. This led to parallel studies of genetics and cytogenetics.
- Gene expression was observed (Lampbrush chromosomes)





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Recent history (Age of Molecular Cytogenetics)

- Gene localization (*in situ*)
- Details of chromosome structure
- Studies of genomes (FISH and GISH)
- Role of various chromosome regions is realized
- Artificial chromosomes are made
- Single chromosomes are purified
- etc.



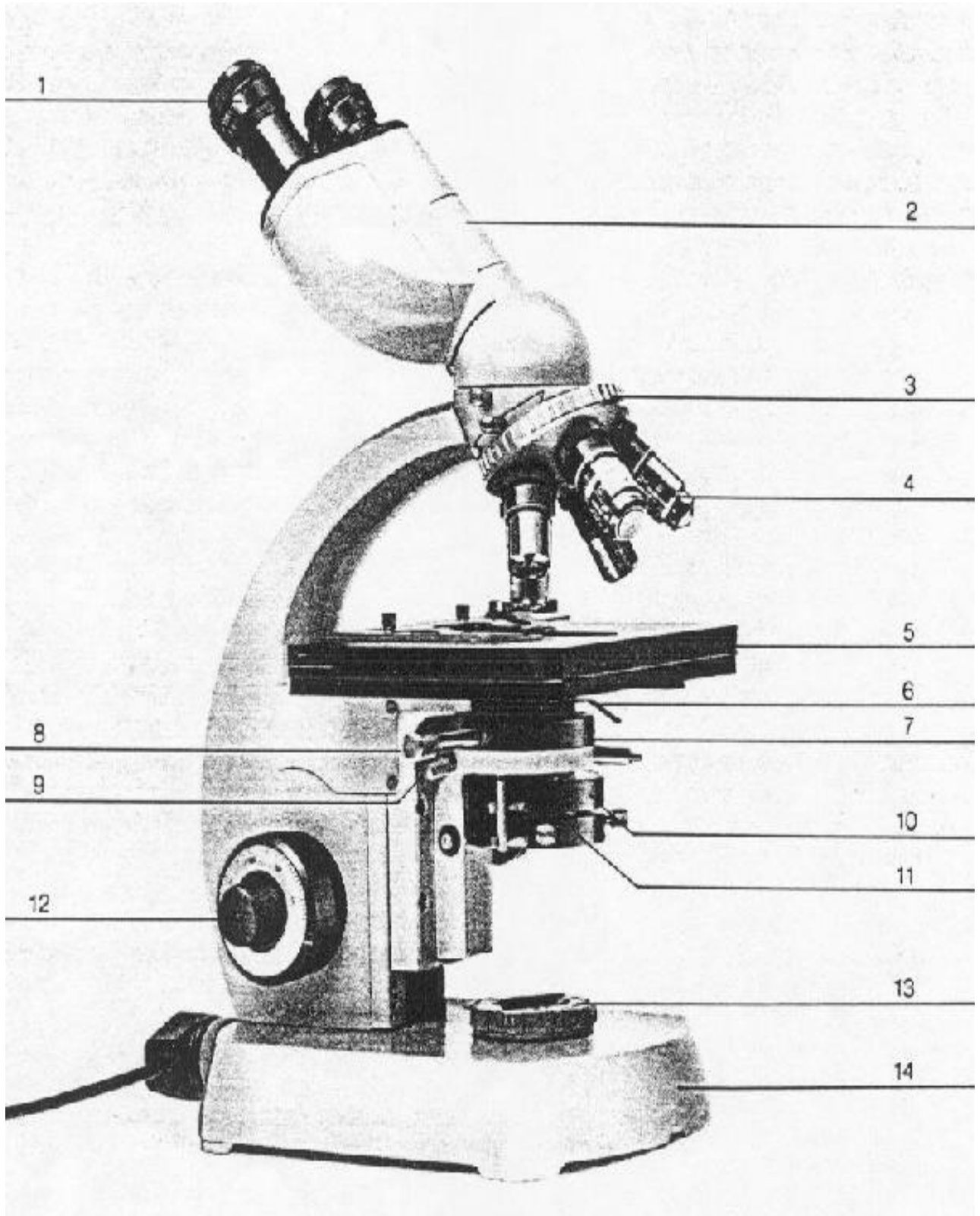
Future

?

Tools of Cytogenetics

Light microscope

manipulating the path of light thru optics



Eyepiece

Tube

Revolving nosepiece

Objective Lenses

Specimen Stage

Iris control

Condenser lever

Condenser

Condenser centering

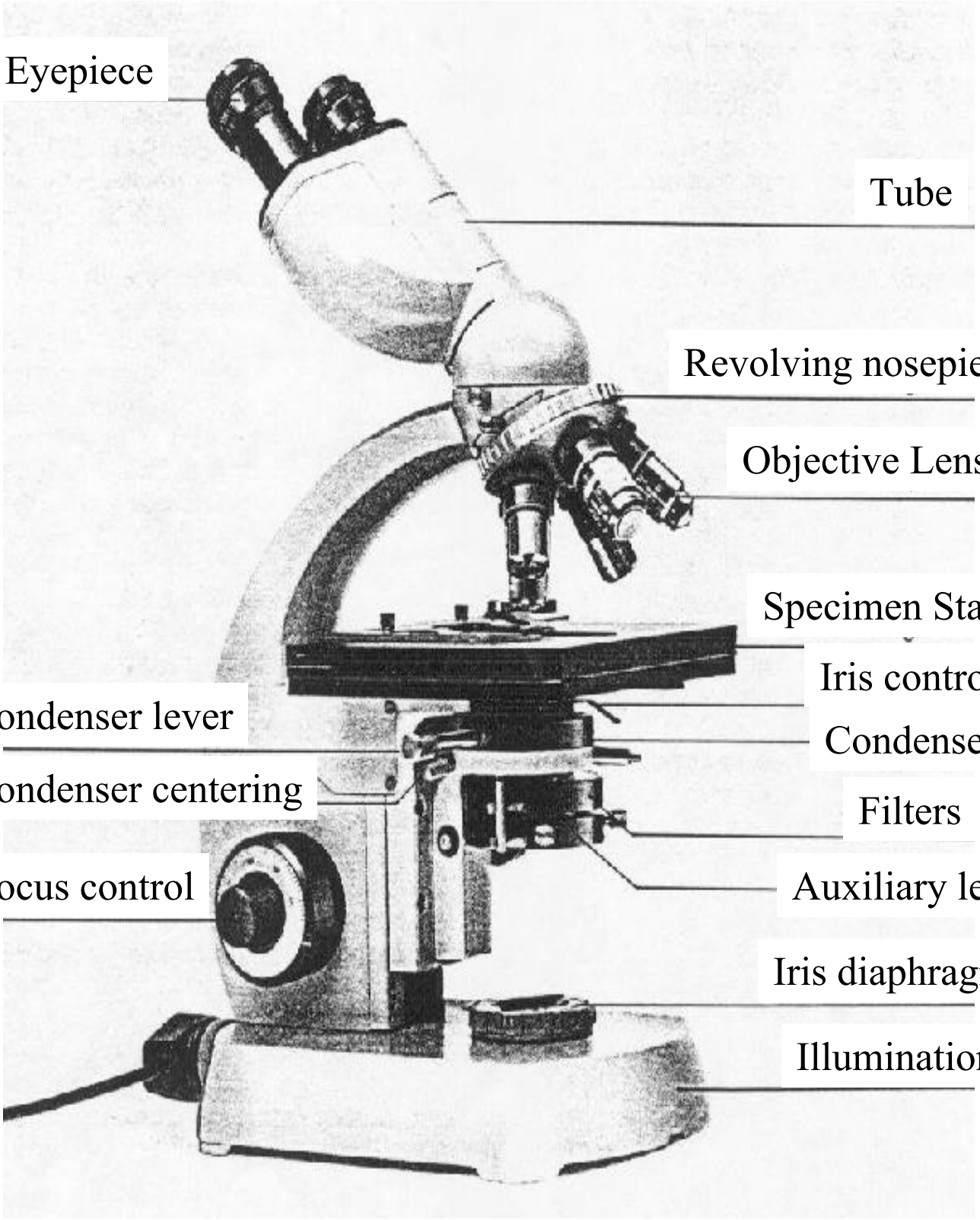
Filters

Focus control

Auxiliary lens

Iris diaphragm

Illumination



Tools of Cytogenetics

Light microscope

manipulating the path of light thru optics

Important factors

- optics
- wavelength of light
- liquid immersion
- phase contrast
- fluorescence
- computer enhancement

Transmitting electron, Scanning electron and Scanning tunneling microscopy have all increased the power of observation

Glossary of terms

Cytogenetics = The study of chromosome number, structure, function and behavior in relations to gene inheritance, organization and expression

Chromosome= A structure composed of DNA and proteins that bears part of the genetic information of the cell

Mitosis= A process of cell division in Eukaryotic cells by which two daughter cells are formed

Meiosis= A two stage type of cell division in sexually reproducing organisms that results in gametes with half the chromosome number of the original cell