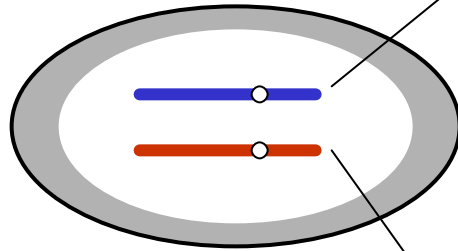


The Somatic Cell Cycle



Diploid Zygote



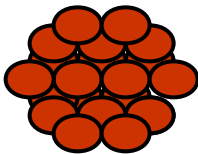
Maternal chromosome

Diploid Zygote

Paternal chromosome



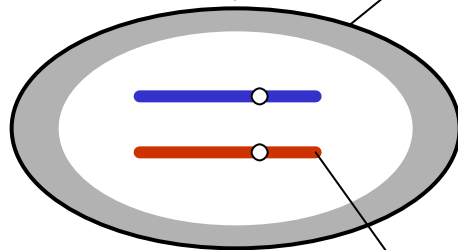
MITOSIS



Diploid organism



MITOSIS



Maternal chromosome

Diploid organism

Paternal chromosome

The Mitotic cell cycle is essential to cell division and growth of an organism

Gene Expression and Cell Division conflict:

➤ Gene expression requires

➤ Cell division requires

Gene Expression and Cell Division are separated into different stages

The Somatic Cell Cycle

Stages of the cell cycle:

➤ **M** Mitosis= period of cell division

➤ **G₁** Gap₁=period during cellular interphase from the end of one telophase to the beginning of DNA replication

➤ **S** Synthesis=period of pre-mitotic interphase when DNA is replicated

➤ **G₂** Gap₂=period during interphase after completion of DNA replication and before beginning of prophase

Interphase

G₁ and **G₂** are called gaps in the cell cycle when no DNA synthesis occurs

Cytological observations of the cell cycle are divided into two parts, interphase and mitosis

Interphase

G_1

1. Period of gene expression
2. Daughter cells retain the diploid set of chromosomes and DNA content is $2c$
3. More variable in length than S, G_2 or M
4. Some event during G_1 is the focus of regulation of cell reproduction in tissues
5. Differentiated cells that cease to reproduce usually contain G_1 amount of DNA ($2c$) whether cessation is reversible or irreversible (G_0)

Interphase

G_1

6. In cells that continue to reproduce, the reproductive rate is governed by the average length of time that cells are retained in the G_1
7. Measurement of DNA content in dormant plant embryos indicate cells are arrested in G_1
8. G_1 may be absent in rapidly proliferating cells or higher organisms, particularly during embryogenesis
9. Once cells progress from G_1 to S, they are committed to proceed through mitosis

Interphase

S

1. Period of DNA synthesis (DNA content goes from $2c$ to $4c$)
2. Autoradiography shows that DNA synthesis is confined to a relatively short period
3. DNA replication is initiated by factors in the cytoplasm
4. DNA replication is initiated by factors in the cytoplasm
 - a) when two or more nuclei share the same cytoplasm, they are nearly always synchronized

Interphase

S

4. DNA replication is initiated by factors in the cytoplasm
 - b) Gurdon (1973) observed that DNA synthesis was initiated when nuclei from various tissue of *Xenopus* were implanted into an unfertilized egg
 - c) Nuclei from adult liver, brain, and blood cells injected into mature eggs of *Xenopus* initiated DNA synthesis within 90 minutes of injection
 - d) Inhibition of protein synthesis in G_1 will inhibit or delay on set of the S phase

Interphase

G_2

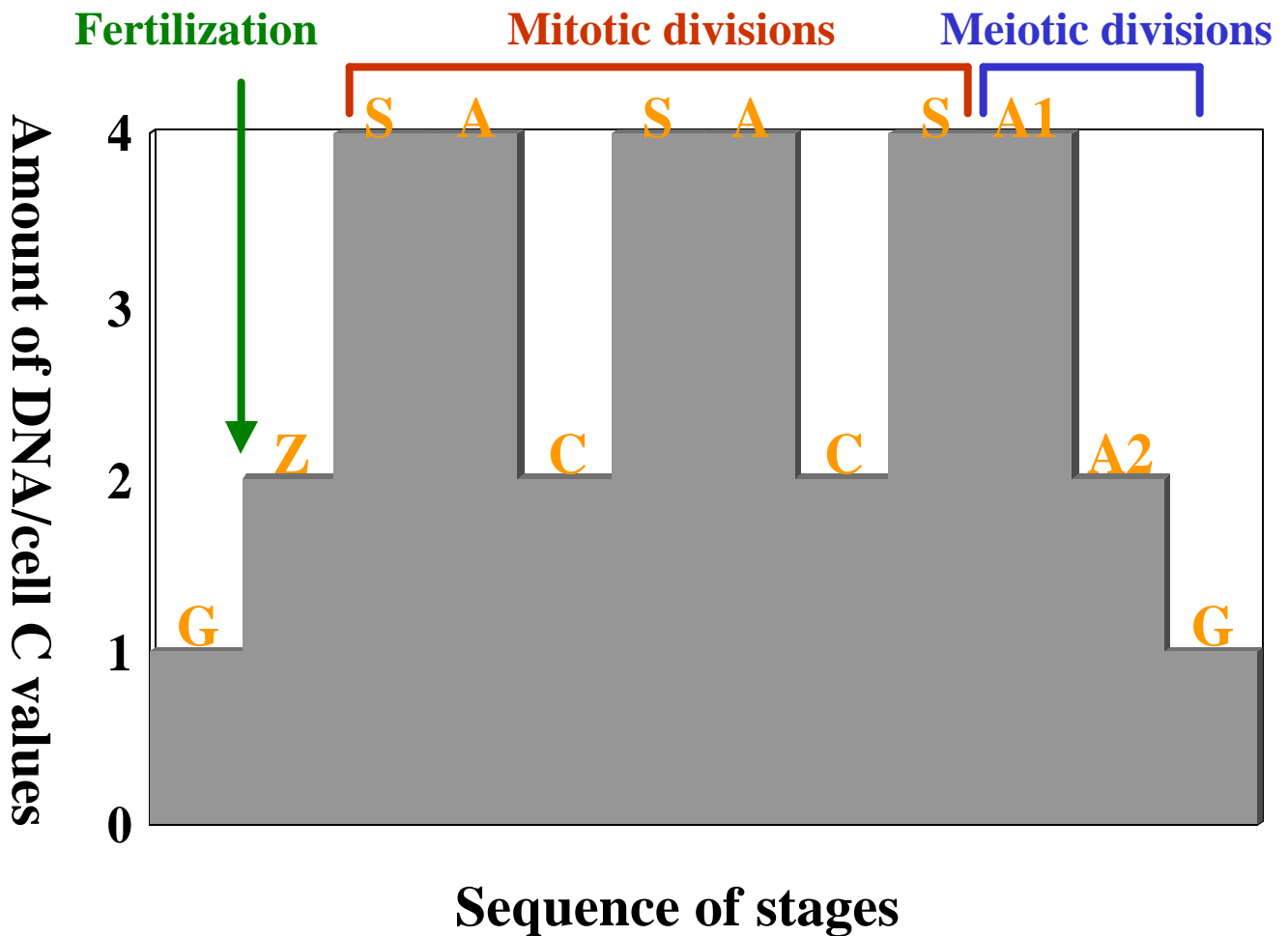
1. The nucleus contains two diploid sets of chromatids (DNA content is **4c**)
2. Period required for cells to synthesize elements necessary for chromosome condensation and the construction and operation of the mitotic apparatus
3. Protein synthesis is necessary for cells to complete most of the G_2 period, But protein synthesis required for mitosis is completed prior to prophase
4. G_2 lasts until mitosis begins

Interphase

G₂

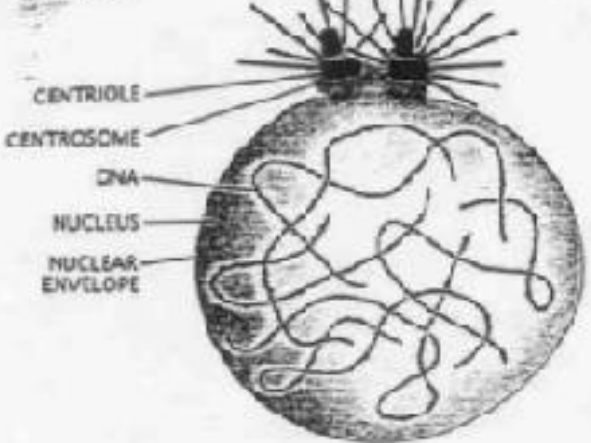
5. The fusion of a mitotic HeLa cell with an interphase cell results in condensation of interphase chromosomes (Rao and Johnson, 1970)
 - a) Chromosomes do not have to be replicated to respond to the condensation signal
 - b) The condensation factor is effective across phylogenetic lines (Bull sperm, chicken erythrocytes, and mosquito were condensed by the HeLa factor)

Life cycle of a sexually reproducing organism correlated with the amount of DNA per cell

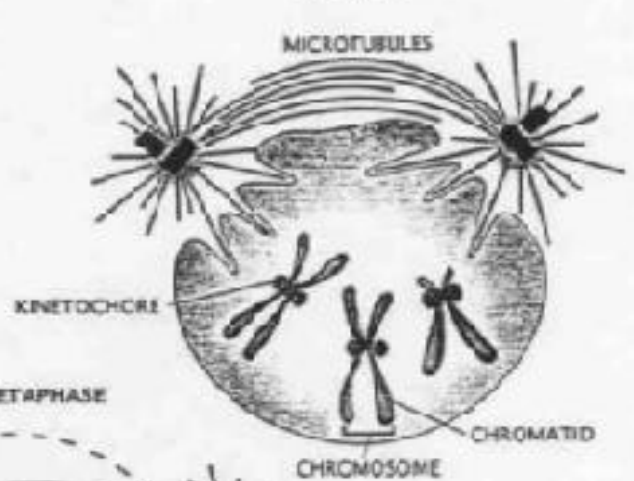


G = Gamete, **Z** = Zygote, **S** = Period of DNA synthesis, **A** = Mitotic Anaphase, **A1** = First meiotic anaphase, **A2** = Second meiotic anaphase

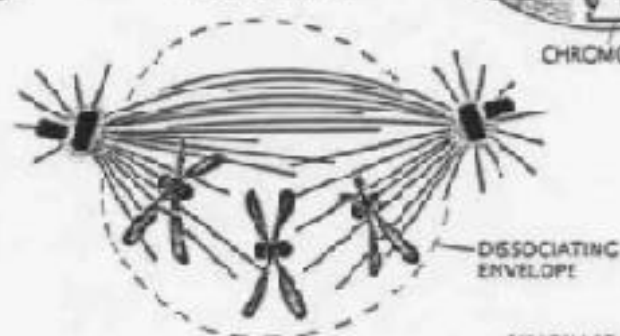
INTERPHASE



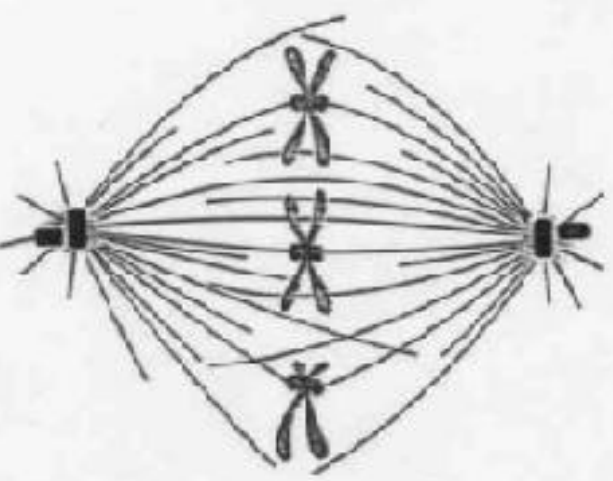
PROPHASE



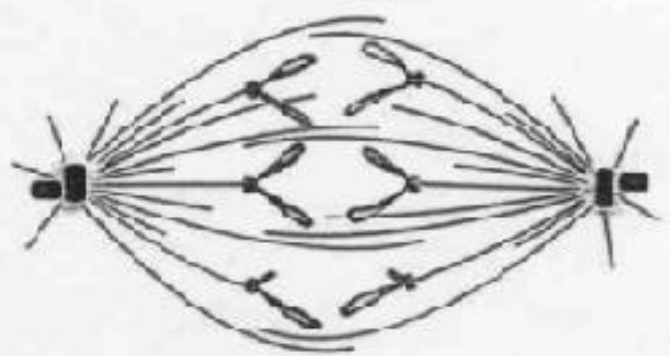
FROM METAPHASE



METAPHASE



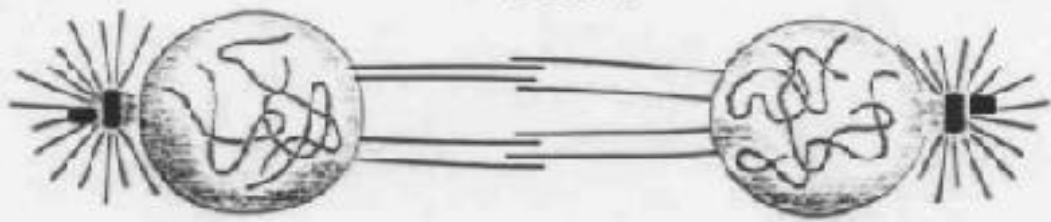
ANAPHASE A



ANAPHASE B



TELOPHASE



Stages of Mitosis

➤ **Interphase:**

- ✓ Chromosomes are fine diffuse strands and are difficult to see with light microscopy
- ✓ Chromosomes are duplicated
- ✓ The nuclear envelope is intact

➤ **Prophase**

- ✓ Chromosomes condense into distinct structures
- ✓ Chromosomes become visible with light microscopy

➤ **Prometaphase**

- ✓ Further chromosome condensation
- ✓ Nuclear envelope disintegrates
- ✓ Chromosomes become associated with spindle apparatus
- ✓ Sister chromatids remain attached at the centromere, but begin to separate at other regions

Stages of Mitosis

➤ **Metaphase**

- ✓ Sister chromatid pairs are aligned near the spindle with centromeres still associated
- ✓ The centromeres orient toward opposite poles and are lined up on the metaphase plate

➤ **Anaphase**

- ✓ Sister chromatid pairs separate with one member of each pair moving toward the poles

➤ **Telophase**

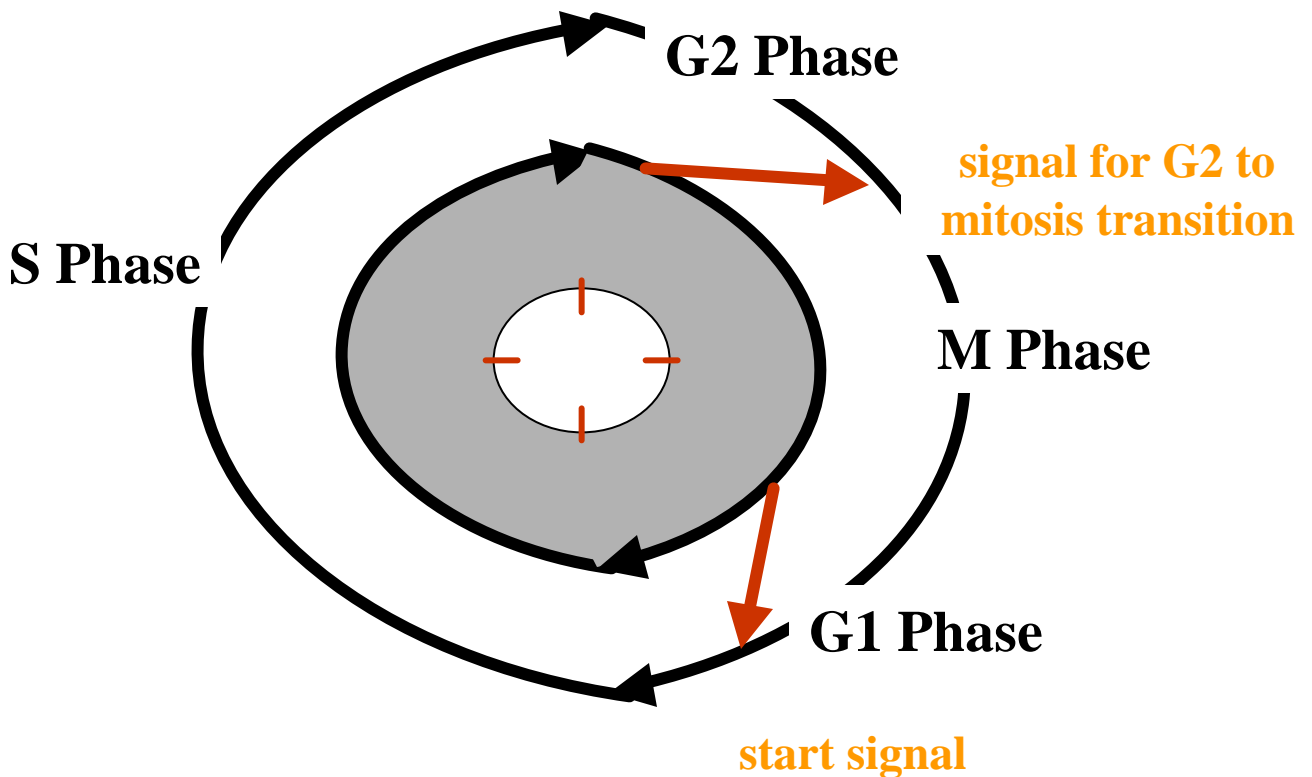
- ✓ Chromatids reach opposite poles and poleward movement ceases
- ✓ New nuclear envelope is formed around each diploid chromosome set
- ✓ Chromosomes begin to decondense

Stages of Mitosis

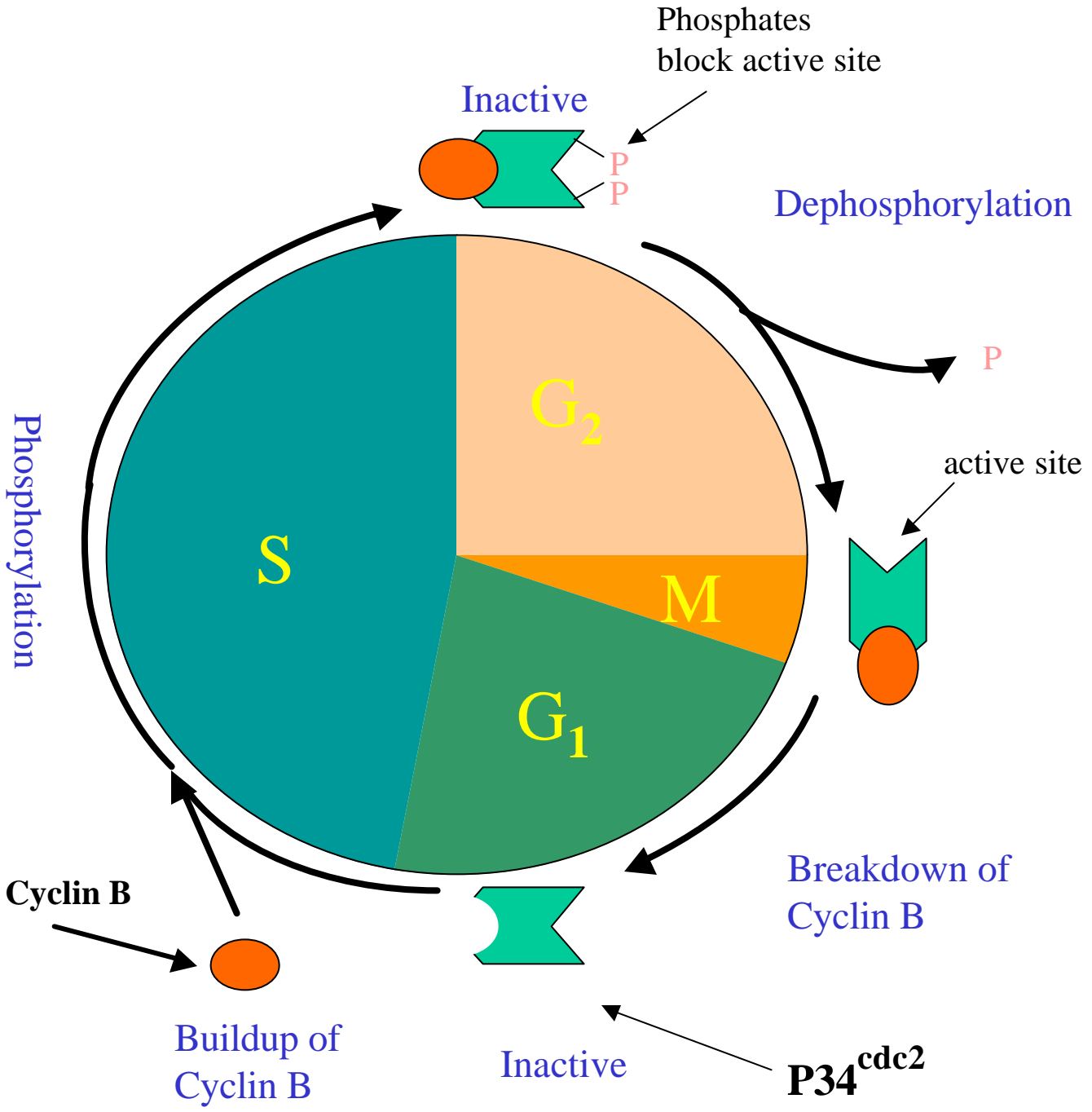
➤ Cytokinesis

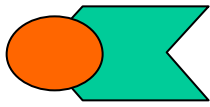
- ✓ During mitosis doubling of all the cytoplasmic organelles also occurs, they are distributed to daughter cells during this stage
- ✓ Central ring of myosin and actin fibers contract to separate the daughter cells
- ✓ In plants the cell plate is laid down in preparation for the rigid cell wall

Control of Mitotic Cell Division



**Molecular
clock**




 = MPF or maturation-promoting factor or mitosis promoting factor

$$\text{Mitotic Index} = \frac{\text{\# of mitotic cells}}{\text{Total \# of cells}}$$

Mitotic cells = cells in stages from prophase to telophase

Glossary of terms

The Somatic Cell Cycle= Events that occur from one cell division to the next

2C= DNA content of nucleus in the somatic cells of an organism

Chromatid= A single chromosomal strand; a metaphase chromosome is composed of two “sister” chromatids

Centromere= A region of chromosome from which kinetichore microtubules radiate during mitosis or meiosis

Kinetochores= A specialized region on the centromere that links each sister chromatid to the mitotic spindle

Heterochromatin= non-transcribed eukaryotic chromatin that is so highly compacted that it is visible with a light microscope during interphase

Euchromatin= The more open, unraveled form of eukaryotic chromatin, which is available for transcription