What can halt cell cycle?

The cell cycle is controlled at **three *checkpoints*:**

1. During G1 prior to the S stage
2. During G2 prior to the M stage
3. During the M stage prior to the end of mitosis

**At the G1 checkpoint:**

* + DNA is checked for damage before getting replicated.
  + ***p53*** protein stops the cycle at the G1 checkpoint when DNA is damaged.
  + It attempts repair, but will initiate apoptosis when repair is not possible. Many kinds of tumors lack an active *p53* gene.
  + Signaling protein, **cyclin**, increases and decreases as the cell cycle continues.
  + Cyclin must be present for cell to proceed from the G1 🡪S stage and from G2 🡪 M stage

**At the G2/M checkpoint:**

* checks for replication errors and cell size
* mitosis will not occur if DNA is damaged or not replicated.

**At the M checkpoint:**

* mitosis stops if chromosomes are not properly aligned.
* *Apoptosis* is programmed cell death.
* Apoptosis occurs because of two sets of enzymes called *capsases*.
* The first set, the “*initiators*” receive a signal to activate the second set, the “*executioners*”.
* The second set of capsases activate enzymes that tear apart the cell and its DNA.

**Cdk** (cyclin dependent kinase, adds phosphate to a protein), along with cyclins, are major control switches for the cell cycle, causing the cell to move from G1 to S or G2 to M.

**MPF** (Maturation Promoting Factor) includes the CdK and cyclins that triggers progression through the cell cycle.

**p53** is a protein that functions to block the cell cycle if the DNA is damaged. If the damage is severe this protein can cause apoptosis (cell death).

1. p53 levels are increased in damaged cells. This allows time to repair DNA by blocking the cell cycle.
2. A p53 mutation is the most frequent mutation leading to cancer. An extreme case of this is Li Fraumeni syndrome, where a genetic a defect in p53 leads to a high frequency of cancer in affected individuals.

**p27** is a protein that binds to cyclin and cdk blocking entry into S phase. Recent research suggests that breast cancer prognosis is determined by p27 levels. Reduced levels of p27 predict a poor outcome for breast cancer patients