**Cell Cycle and**

**Regulation of Division**

**Coordination of cell division**

* A multicellular organism needs to coordinate cell division across different tissues & organs
* Critical for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* .

Frequency of Cell Division – varies by cell type

|  |  |
| --- | --- |
| ***cell type*** | ***how often do they divide?*** |
| embryo |   |
| skin cell |   |
| liver cell |   |
| mature nerve/muscle cells |   |

**Overview of Cell Cycle Control**

* **Two irreversible points in cell cycle**
	+ .
	+ ,
* **Checkpoints**
	+ .

**Checkpoint control system**

* **Checkpoints**
	+ **.**
	+ **.**

**3 major checkpoints:**

* + **\_\_\_\_\_\_\_\_\_\_\_\_**
		- can DNA synthesis begin?
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- has DNA synthesis been completed correctly?
		- commitment to mitosis
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- are all chromosomes attached to spindle?
		- can sister chromatids separate correctly?

**G1/S checkpoint**

* **.**
	+ primary decision point
		- “restriction point”
	+ if cell receives “GO” signal, it \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- internal signals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- external signals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ **if cell does NOT receive signal -**
		- **G0 =**
* **G0 Phase**
	+ **non-dividing, differentiated state**
	+ **.**
	+ **.**
	+ **.**
* “Go Ahead” Signals
	+ External Signals
	+ Intrinsic Signals

**Primary mechanism of control**

* + **.**
		- **kinase enzymes**
		- **.**

Cell Cycle Signals – Cell Cycle Controls

* + **.**
		- **.**
		- **.**
	+ **.**
		- **cyclin-dependent kinases**
		- **.**
			* **activates or inactivates proteins**
	+ **Cdk-cyclin complex**
		- **triggers passage through different stages of cell cycle**
		- **Interaction of Cdk’s & different cyclins \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
		- **CDKs & cyclin drive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**



**Proper regulation of cell cycle is so key to life that the genes for these regulatory proteins have been highly conserved**

External Signals of Control – **GROWTH FACTORS**

* + **coordination between cells**
	+ **protein signals released by body cells that stimulate other cells to divide**
		- **\_\_\_\_\_\_\_\_\_\_\_\_ (contact)**
			* **crowded cells stop dividing**
			* **each cell binds a bit of growth factor**
				+ **not enough activator left to trigger division in any one cell**
		- * **to divide cells must be attached to a substrate**
				+ **“touch sensor” receptors**

 ***Example of Growth Factor –***

* **Platelet Derived Growth Factor (PDGF) – made by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_!**
	+ **made by platelets in blood clots**
	+ **binding of PDGF to cell receptors stimulates cell division in connective tissue**

🡪

**Growth Cancers Can Create Cancers**

 Regulatory Genes involved in cancer regulation:

* + - **normally activates cell division**
		- **if switched “ON” 🡪**
		- **example: RAS (activates cyclins)**
		- **normally inhibits cell division**
		- **if switched “OFF” 🡪**
		- **example: p53**

**Cancer is essentially a failure of cell division control**

**🡪 unrestrained, uncontrolled cell growth**

**Key Mutations/Hits that Lead to the Development of Cancer**

|  |  |
| --- | --- |
| **Mutation/"hit"** | **effect on tumor suppresor/onco genes** |
| unlimited growth |   |
| ignore checkpoints |   |
| escape apoptosis |   |
| immortality = unlimited divisions |   |
| promotes blood vessel growth |   |
| overcome anchor & density dependency |   |

**What causes these “hits”?**

Mutations can be triggered by…

 - -

 - -

 - -

