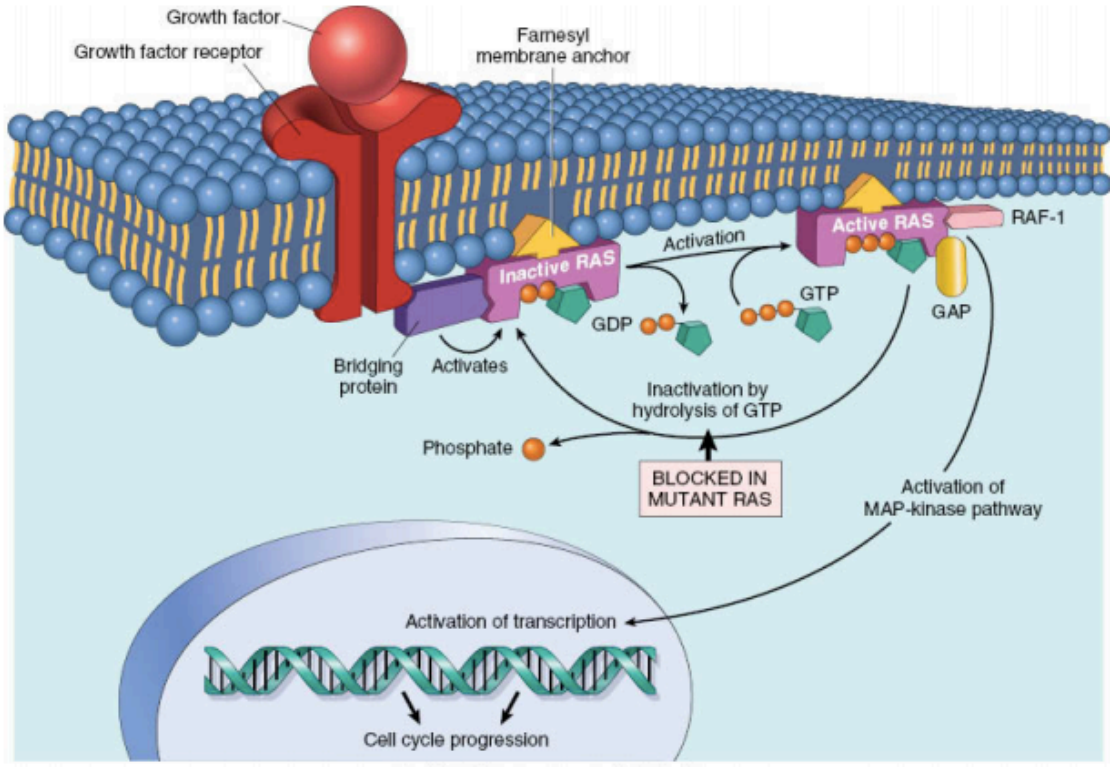
Growth factors:

- Here is a growth factor (red ball) that is binding to a growth factor receptor. When this happens, the shape of the growth factor receptor changes or dimerization of growth factor receptors occurs (two receptors bind together). The signal has to be transmitted from the surface of the cell to the nucleus in order to activate the genes that tell the cell to grow/divide.
- Cancer cells may stimulate the growth factor receptor to think it's got growth factor attached (permanently activated growth receptor). E.g. Point mutation that causes the dimerization of growth factor receptors without growth factor needing to bind.
- Cancer cells may make/secrete their own growth factor. E.g. Members of fibroblast growth factor family (FGFs) secreted by certain breast and gastrointestinal cancers and melanomas. The protein is normal but it is secreted inappropriately (too much).
- Cancer cells may make a lot more receptors than other cells (overexpressing growth factor receptors) so that they have a selective advantage to grow more than other cells. E.g. Epidermal growth factor receptor (EGFR) is over-expressed in 80% of lung squamous cell carcinomas. A similar receptor (HER-2) is over-expressed in 25% of breast cancers.



- The signal needs to go from the surface of the cell to the nucleus.
- A protein called 'RAS' (pink on diagram) is used to do this.
- Growth factor receptors (red) are coupled to RAS with bridging proteins (purple).

- Once growth factor binds to growth factor receptor, the RAS changes shape and it can bind to GTP (guanosine triphosphate).
- GTP binds to RAS, causing RAS to change shape and activate which activates a MAP-kinase pathway to the nucleus.
- Transcription factors are activated in the nucleus. They turn on the expression of genes.
- RAS cleaves GTP into GDP and is inactivated until more growth factor binds.
- Cancer cells may have a mutation that causes RAS to be unable to cleave GTP to GDP, so that it is permanently switched on.
- RAS mutations are found in 15-20% of all human tumours.

Transcription factors:

- Myc is a transcription factor that turns on many genes involved in cell proliferation.
- When a normal cell divides, the growth factor binds to the receptor causing transient activation of RAS (by the binding of GTP) and the transient activation of Myc, which is a transcription factor that initiates the transcription of genes that tell cells to divide.
- Myc is commonly overexpressed in breast, colon and lung cancers.

Burkitt's Lymphoma Translocation

- Can be induced by a virus (E.g. Epstein-Barr virus that causes glandular fever).
- People with this disease have two abnormal chromosomes.
- A part of chromosome 8 is broken off and swapped with a bit of chromosome 14.
- The Myc oncogene on chromosome 8 is swapped to chromosome 14 and ends up in front of the promoter for the gene that makes antibodies.
- Burkitt's lymphoma is a lymphoma caused by B-cells that make antibodies.