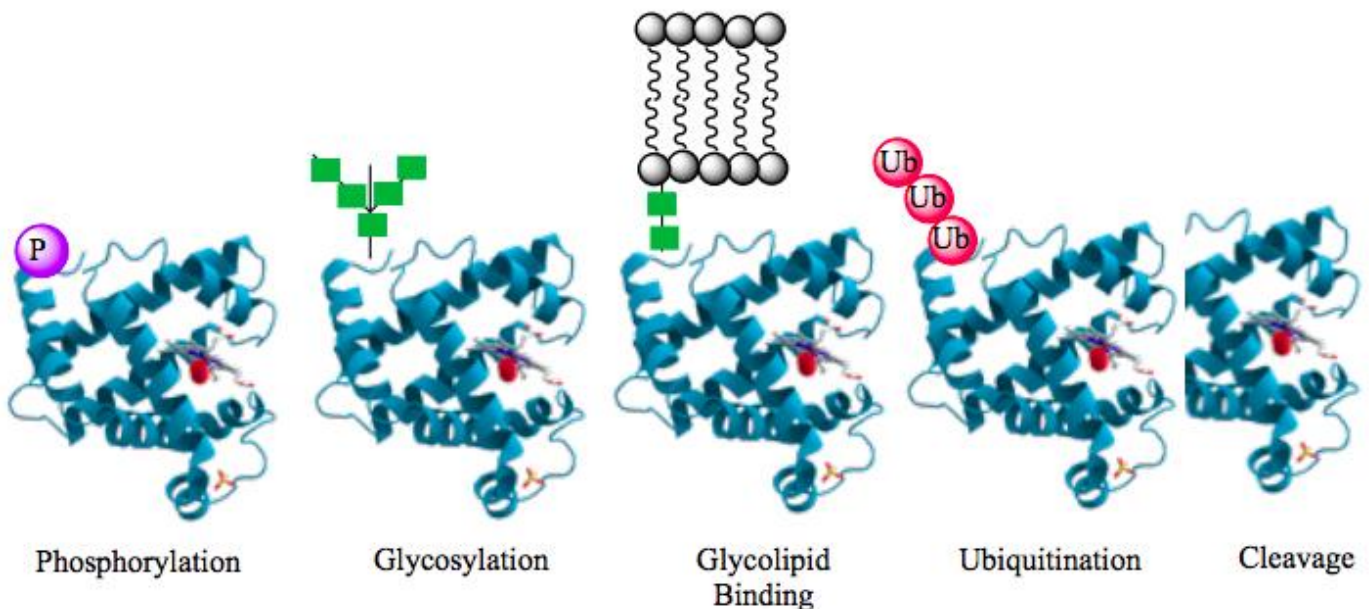


## CONCEPT: PROTEIN REGULATION

### Covalent Modifications

- Modifications to proteins can affect their \_\_\_\_\_.
- **Phosphorylation** is the reversible addition of a phosphate group to one or more amino acid side chains
  - Carries two negative charges and can cause conformational change
  - *Kinases* catalyze addition of the phosphate group; *Phosphatases* causes removal (dephosphorylation)
- **Glycosylation** is the reversible addition of carbohydrates
  - *N-linked* if attached to nitrogen atom; *O-linked* if attached to oxygen atom
- Modifications also occur by the \_\_\_\_\_ addition of lipids
  - **Glycolipids** are lipids linked to oligosaccharides (sugars) which can be added to proteins to anchor them
  - Other types include *prenylation*, *palmitoylation* and *N-myristoylation* (each named based on the lipid type)
- **Ubiquitination** is the addition of ubiquitin proteins which target the protein for degradation
- **Cleavage** can occur to irreversibly remove a section of the protein
  - Cleavage of targeting signal sequences allows release of proteins sequestered in one area

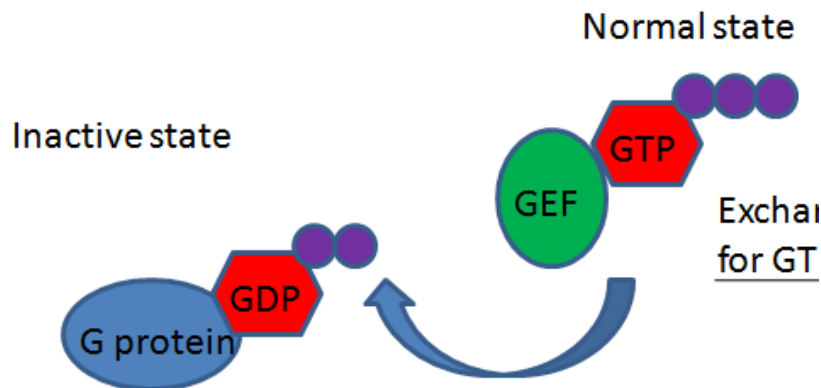


### EXAMPLE: Types of protein modifications

#### GTP and Calcium Binding

- Binding and hydrolysis of **GTP** acts as a major source of protein \_\_\_\_\_
  - Proteins bind GTP in a special GTP-binding domain
    - GTP hydrolysis can control itself OR the function of other proteins to which the GTP-protein is bound
  - GTP hydrolysis to GDP results in conformational changes that inactivates the GTP- protein
  - The **Ras** protein is a major GTP binding cellular regulator
    - Misregulation of this protein leads to a variety of cancers
- Binding of Calcium \_\_\_\_\_ a variety of proteins
  - Calcium concentration is low in the cytosol
    - Changes in concentration can cause activation/inactivation of calcium binding proteins

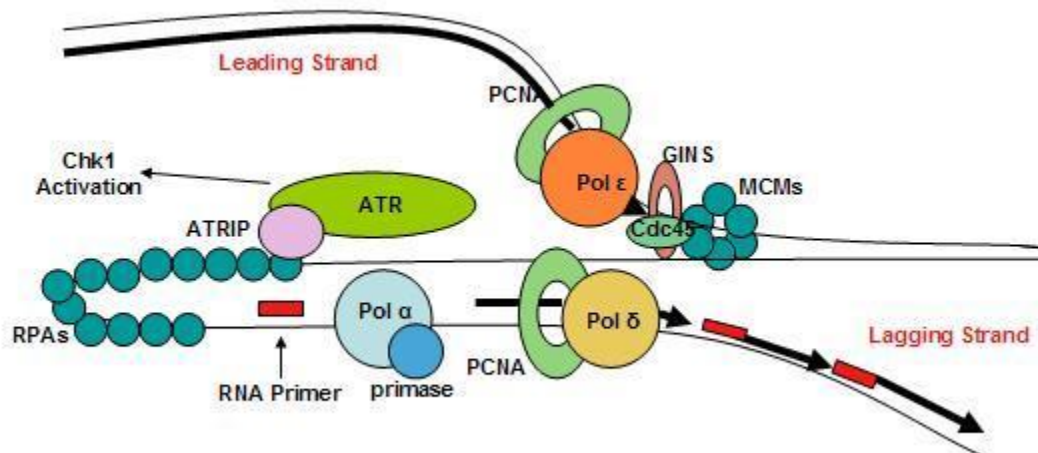
**EXAMPLE:** G proteins are inactive when bound to GDP and active when bound to GTP



#### Protein Machines

- **Protein Machines** are protein complexes made up of 10+ proteins
  - These machines have \_\_\_\_\_ and dynamic parts
    - Each part has to be positioned in a specific way to work properly
  - Control of these machines depends on control of each individual part
    - Many layers of regulation

**EXAMPLE:** A protein machine consists of many parts that are each independently regulated



## PRACTICE

1. Which of the following is not a protein modification that allows for protein regulation?

- a. Ubiquitination
- b. Phosphorylation
- c. Glycosylation
- d. Noncovalent interactions in the binding site

2. Hydrolysis of GTP to GDP causes what to occur to a GTP-Binding protein

- a. It marks it for degradation
- b. It cleaves it
- c. It activates it
- d. It inactivates it

3. True or False: To regulate large protein complexes there is a single, powerful regulator of the entire complex.

- a. True
- b. False