ME 498 / ME 599

Biological Frameworks for Engineers
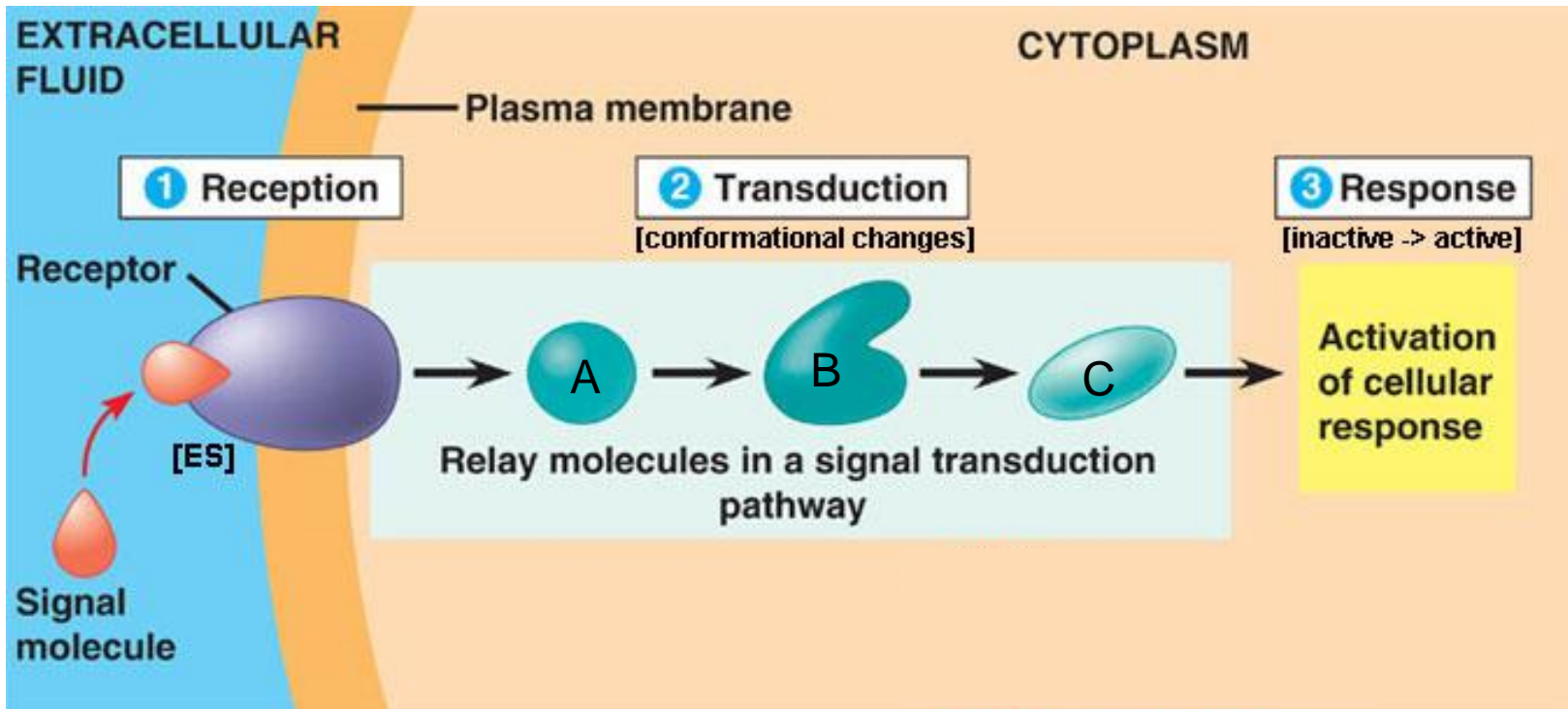
ME 498 / ME 599

Cell Signaling

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Cell Signaling
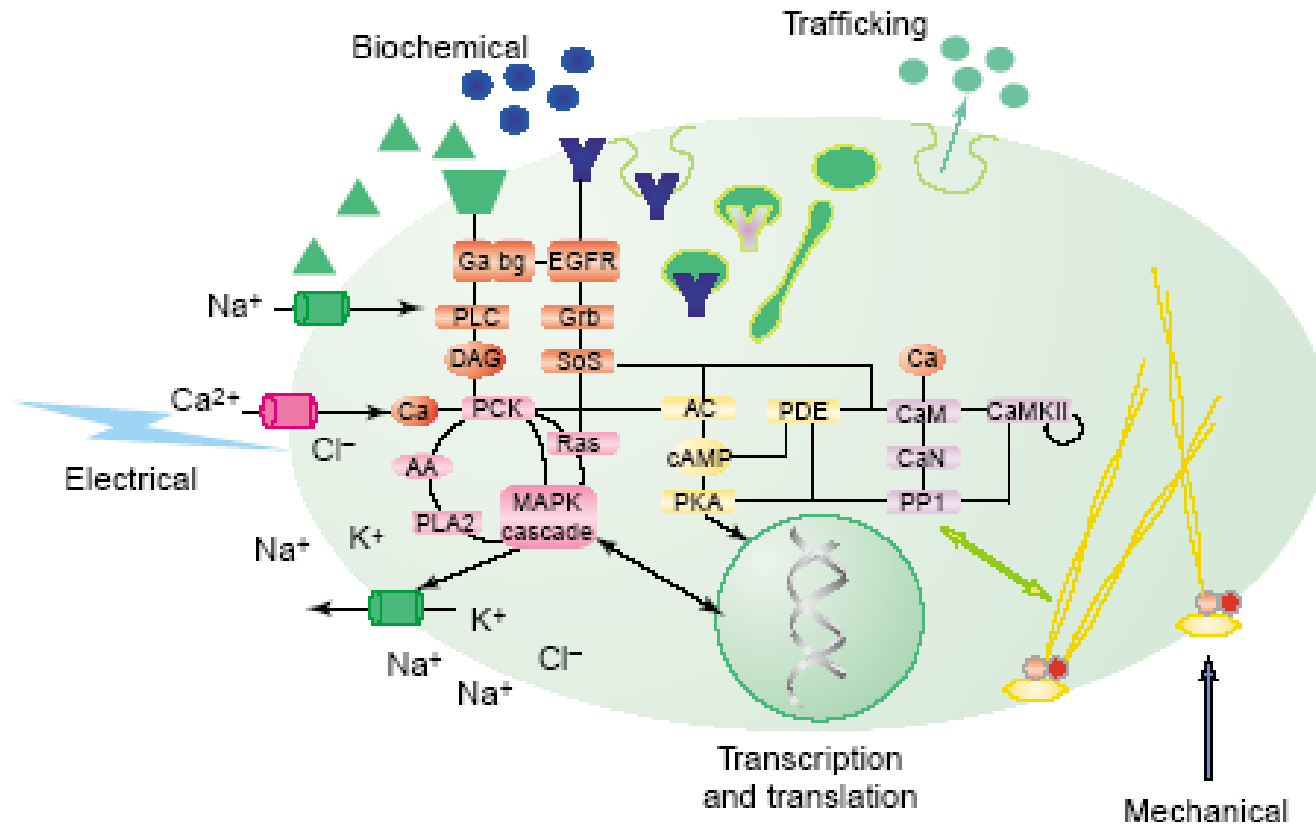
Cell Signaling

Signal Logic

Latent gene regulators activate at cell surface and initiate transcription

Scaffolds cluster proteins together

Relays simply pass along a signal

Adaptors transmit signal between two others

Bifurcators involve multiple pathways

Amplifiers enhance a signal strength

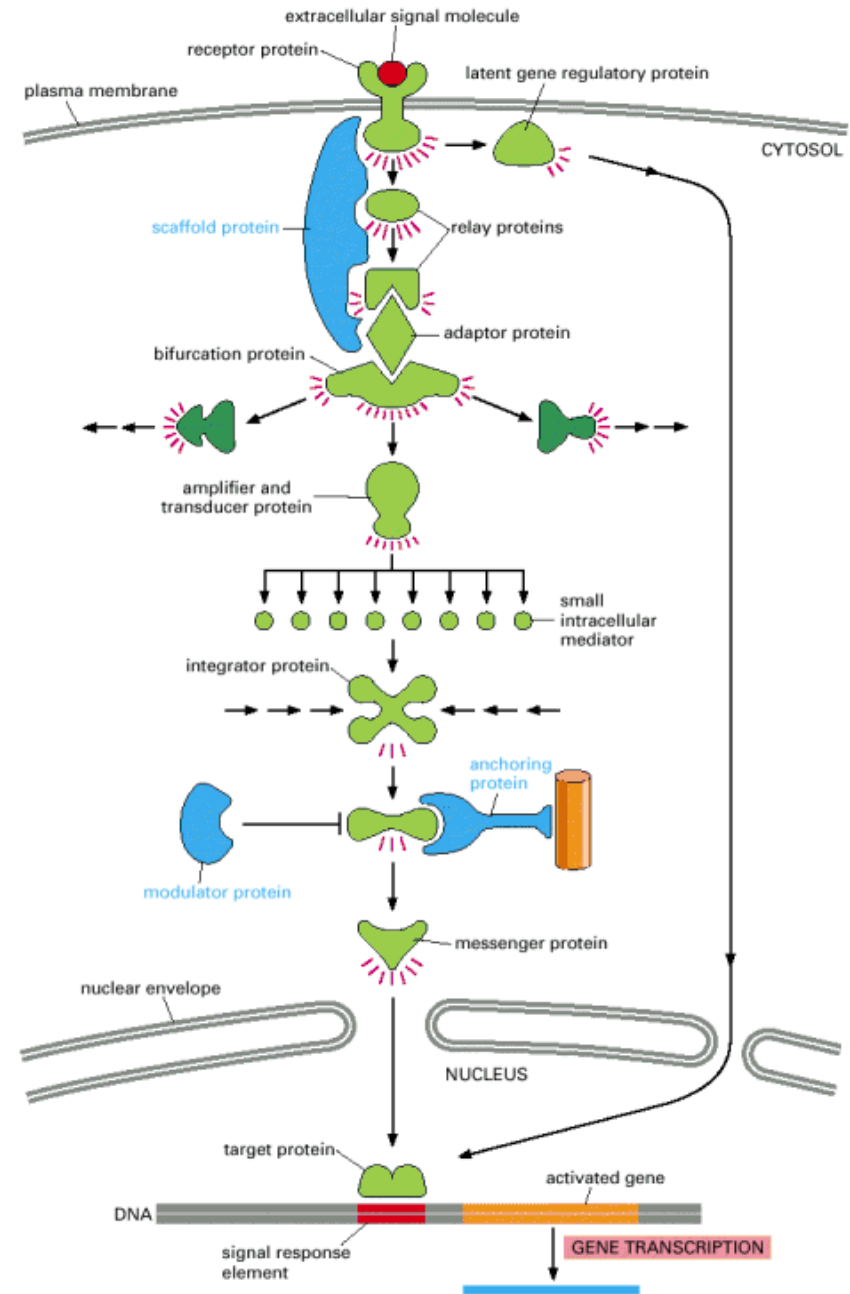Transducers covert signal to other forms

Small intracellular molecules promote rapid signal transport

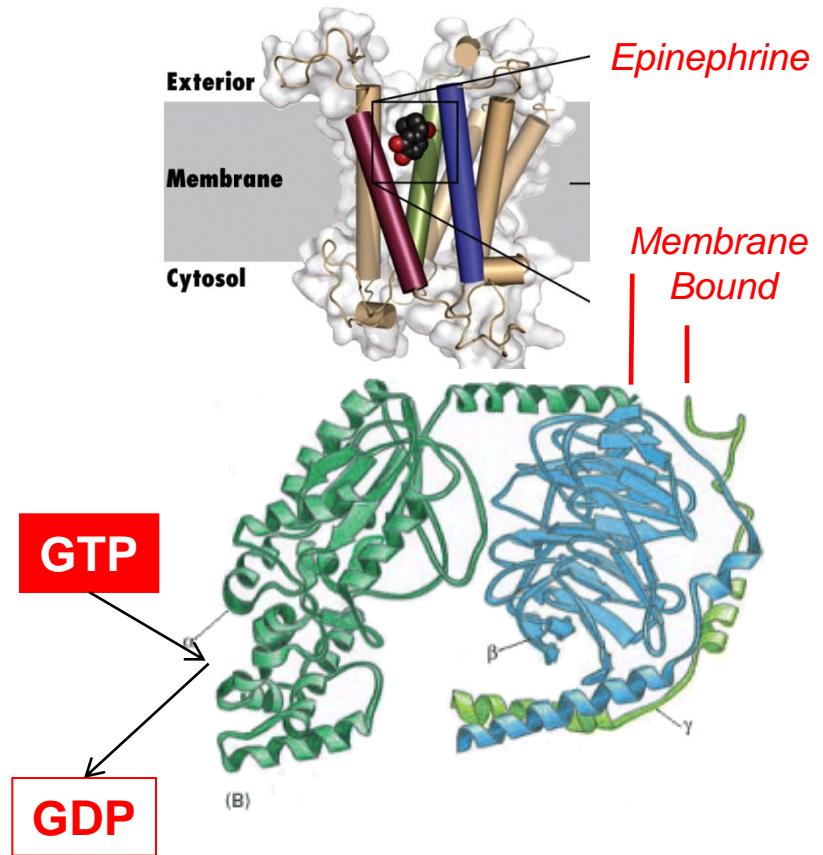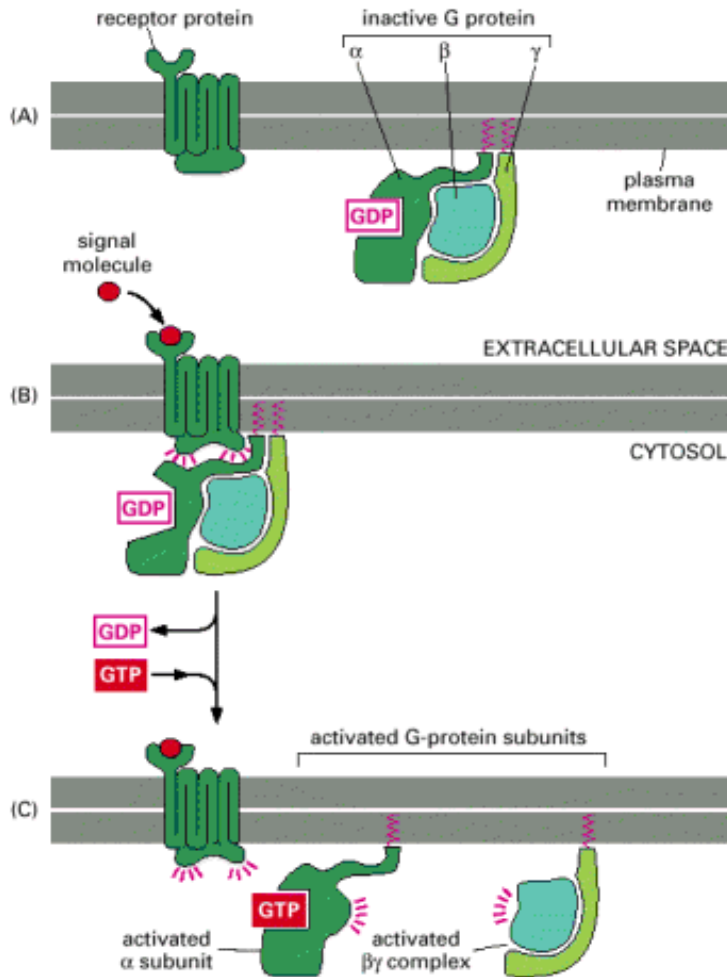Integrators cross-reference different signaling pathways

Modulators enhance signaling activity

Anchors localize proteins at key sites
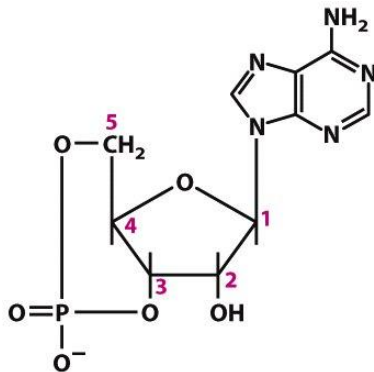
Messengers carry signal into nucleus

G-Protein Linked Receptors
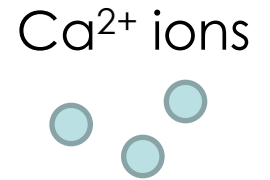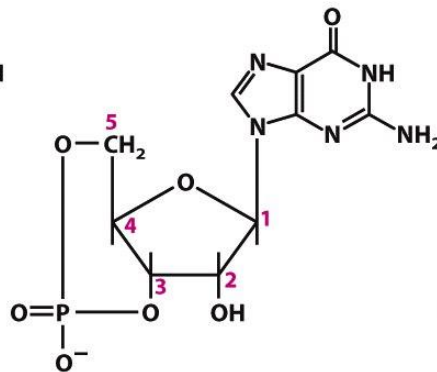

Epinephrine

Membrane Bound

GTP

GDP

Secondary Messengers

- Carries signal by change in concentration

Ca^{2+} ions

3′,5′-Cyclic AMP (cAMP)

3′,5′-Cyclic GMP (cGMP)

Fatty acyl groups

Glycerol

1,2-Diacylglycerol (DAG)

Inositol 1,4,5-trisphosphate (IP$_3$)

Activates protein kinase A (PKA)

Activates protein kinase G (PKG) and opens cation channels in rod cells
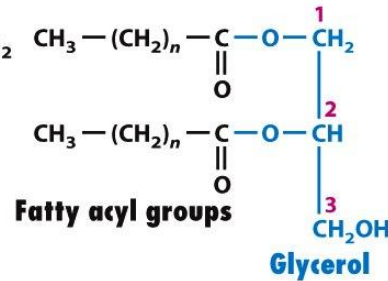
Activates protein kinase C (PKC)

Opens Ca^{2+} channels in the endoplasmic reticulum

Figure 15-9
Molecular Cell Biology, Sixth Edition
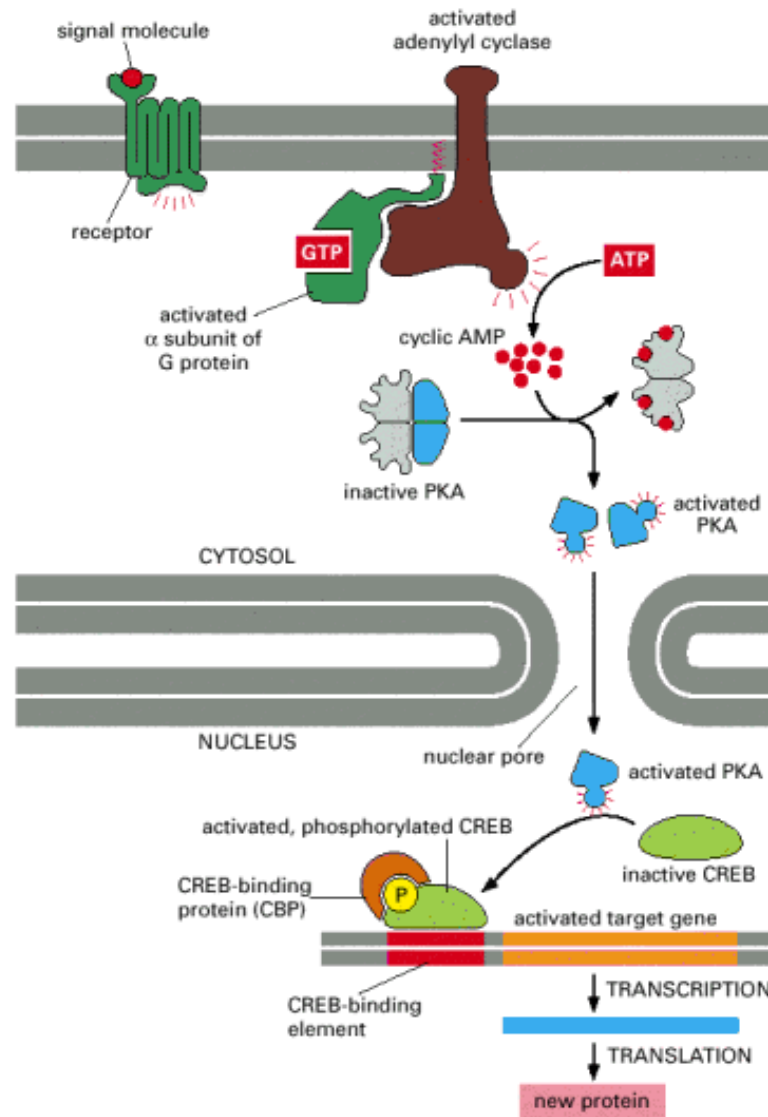© 2008 W. H. Freeman and Company

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Phosphorylation

- Kinase:
  - attachment of phosphate group from ATP
  - binds to –OH amino acid on Serine (S), Threonine (T) or Tyrosine (Y)

- Phosphatase:
  - removal of (P)
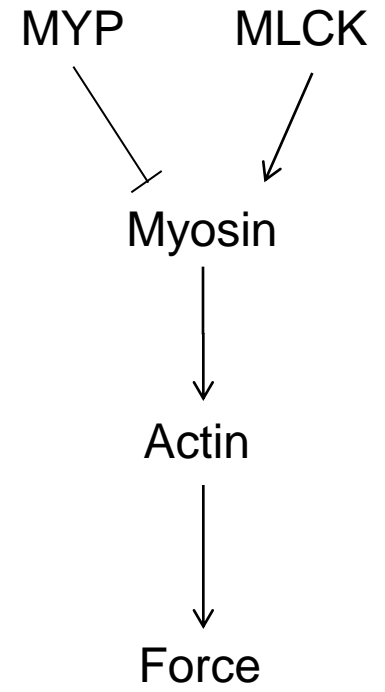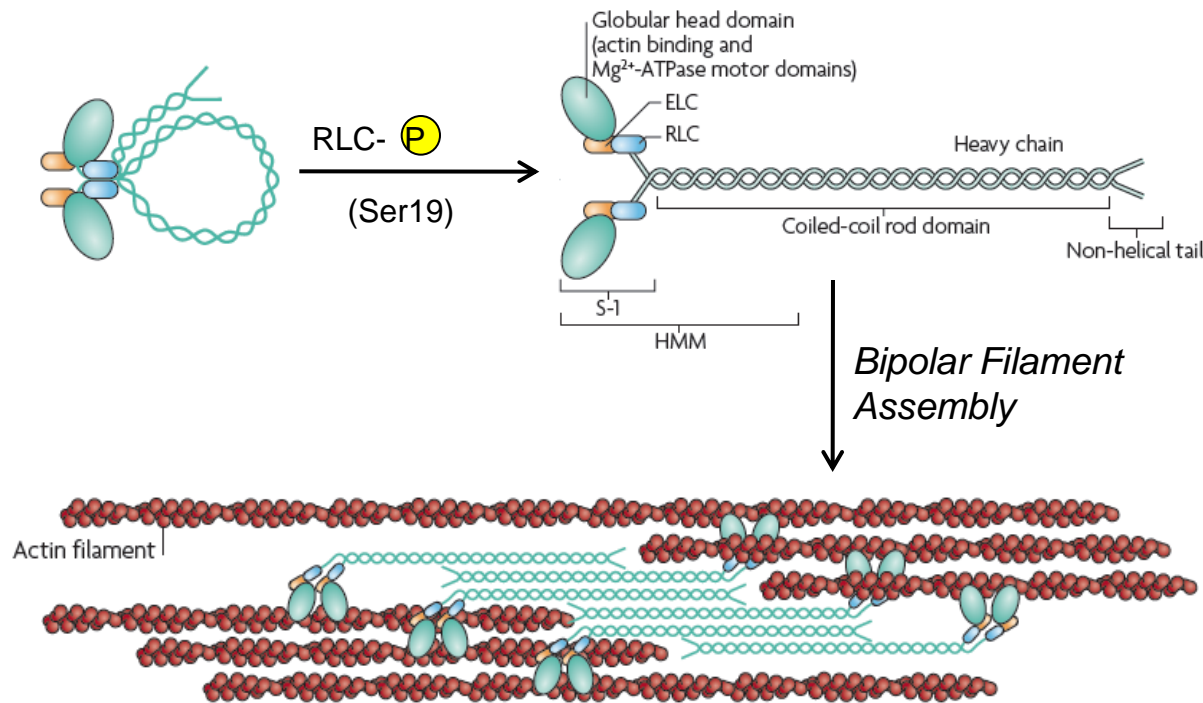
- Conformational Switch
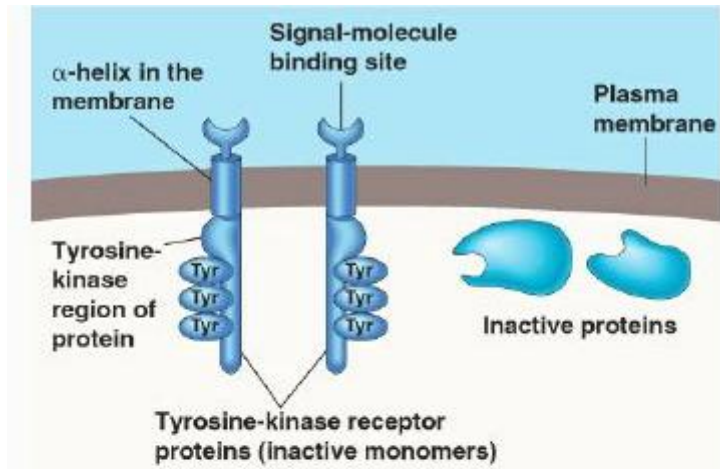 - Off→On or On→Off
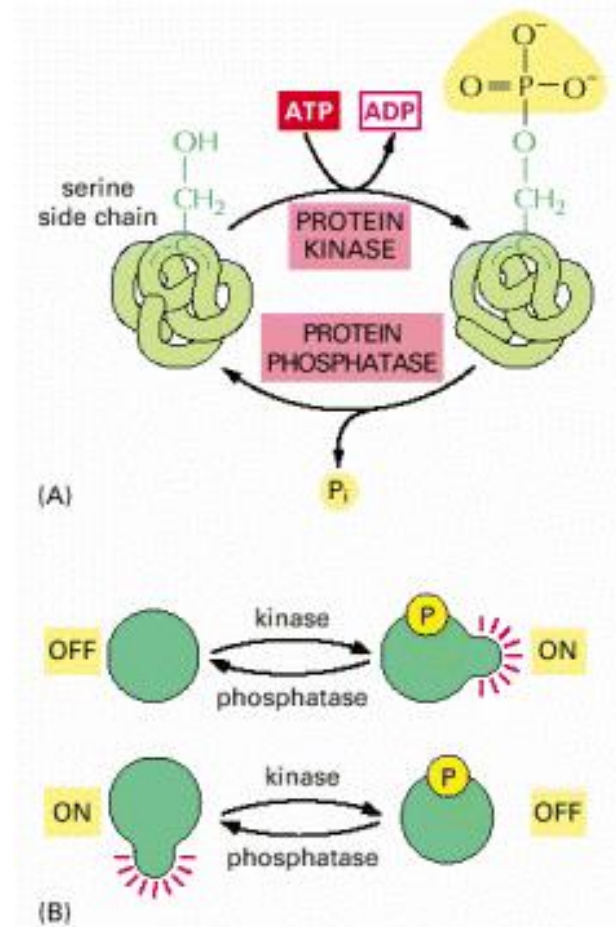
Gene Transcription

Nonmuscle Myosin Activation

Phosphorylation needed for contractile filament assembly

(10S) Folded, Blocked State   (6S) Unfolded, Activated State

RLC- Ⓟ

(Ser19)

Globular head domain
(actin binding and
Mg²⁺-ATPase motor domains)

ELC

RLC

Heavy chain

Coiled-coil rod domain

Non-helical tail

S-1

HMM

Bipolar Filament Assembly

Actin filament

MYP   MLCK

Myosin

Actin

Force

Receptor Tyrosine Kinase
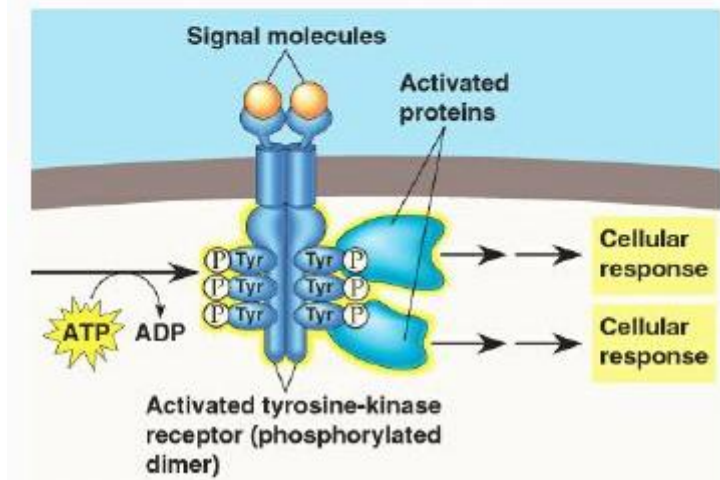
Epidermal Growth Factor Receptor Activates Ras

Binding of hormone causes receptor dimerization kinase activation and phosphorylation of cytosolic receptor tyrosine residues
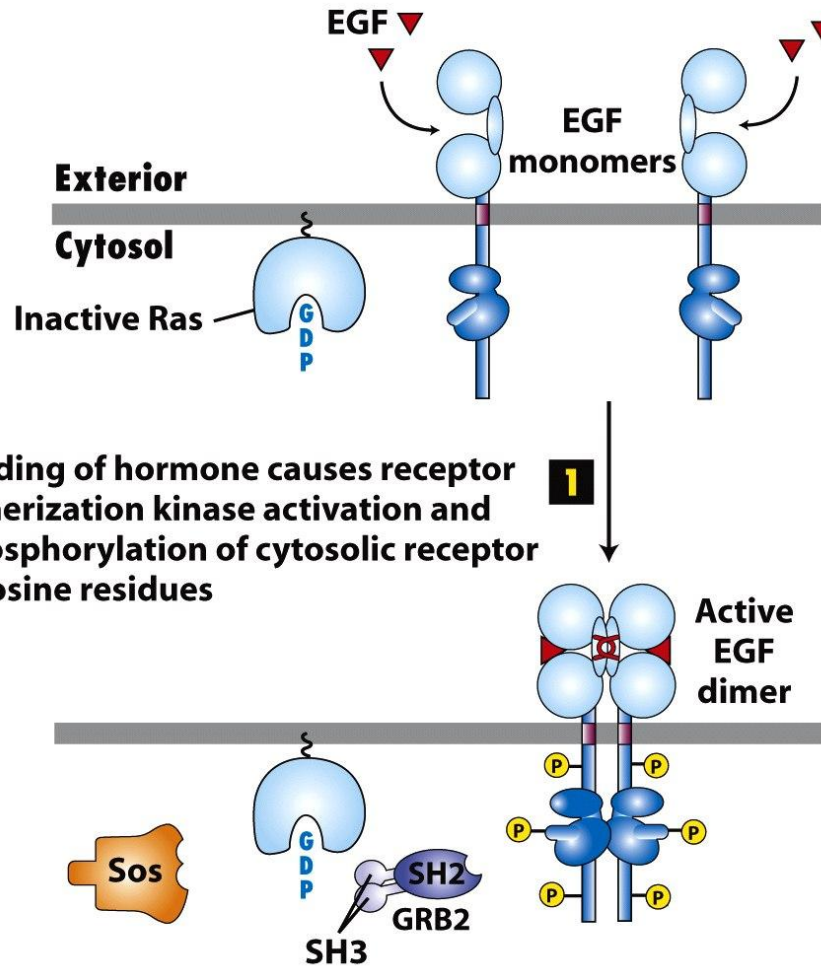
1

Figure 16-20 part 1
Molecular Cell Biology, Sixth Edition
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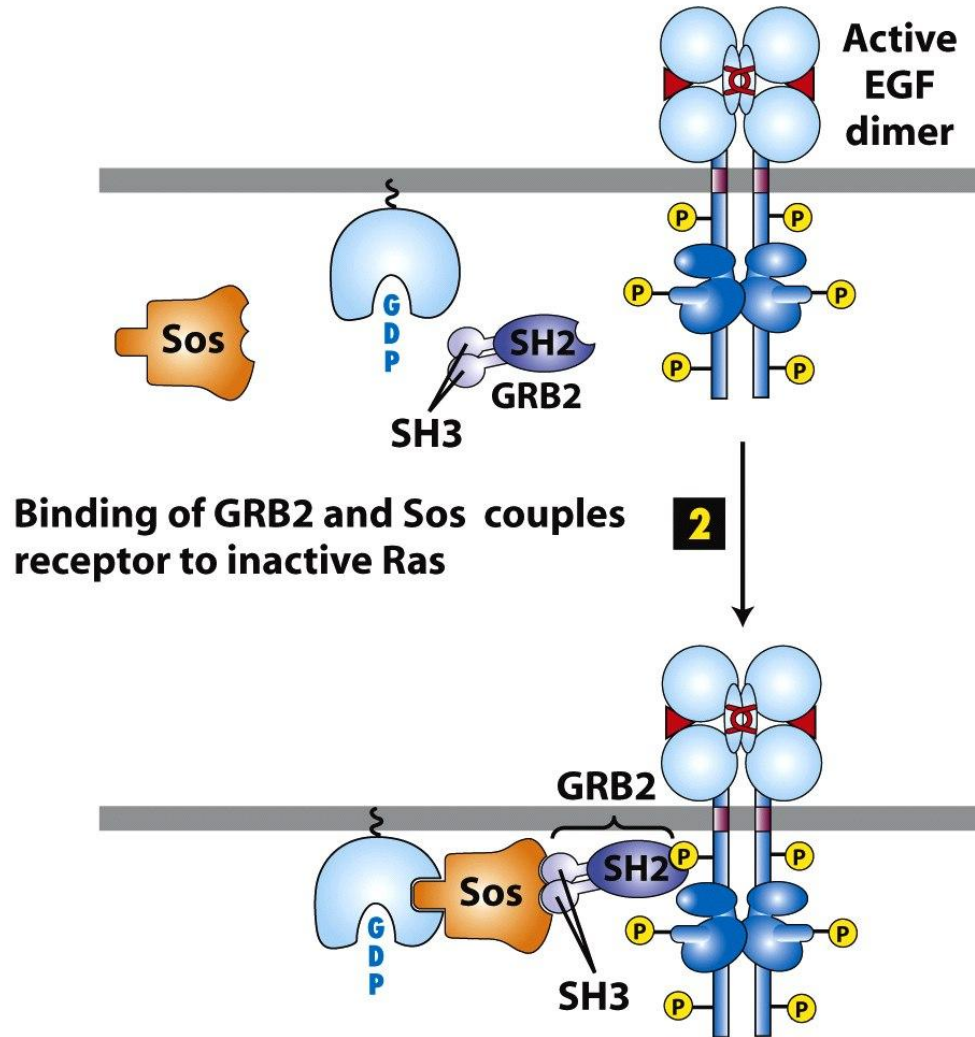
EGFR-P → GRB2-SOS-Ras

Figure 16-20 part 2
Molecular Cell Biology, Sixth Edition
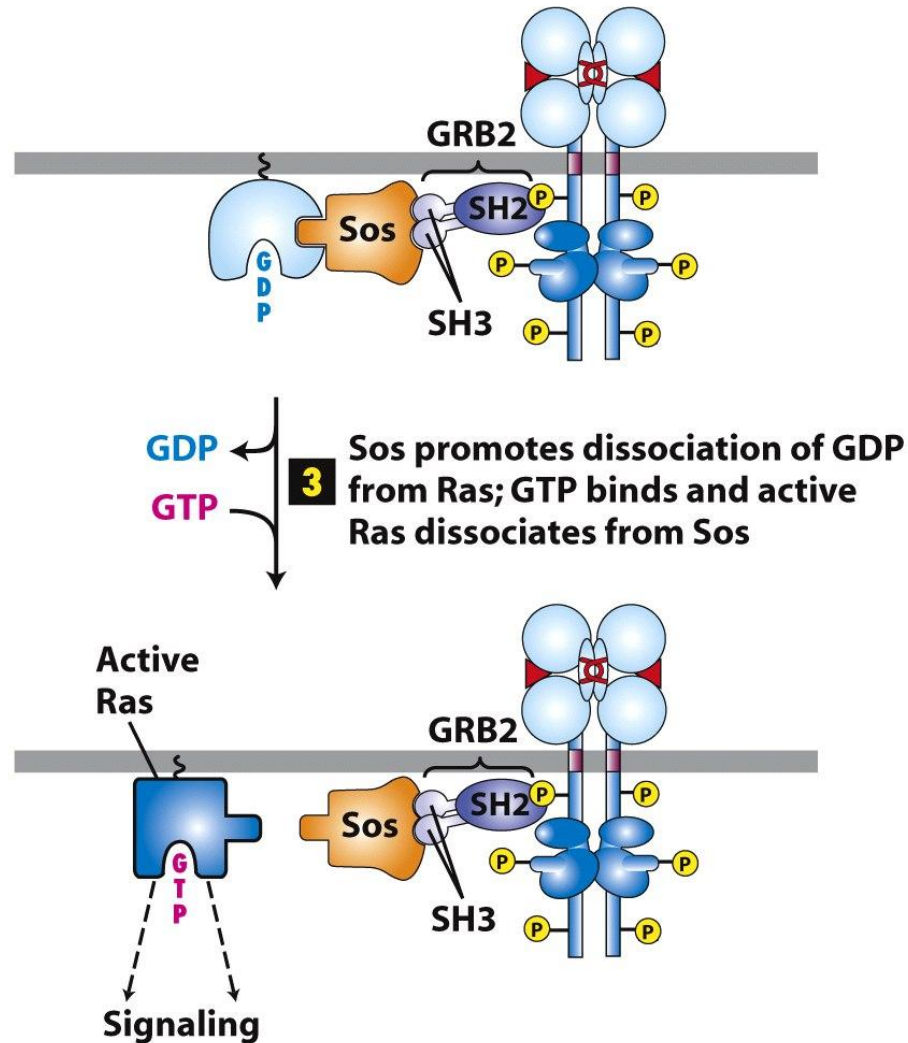© 2008 W. H. Freeman and Company
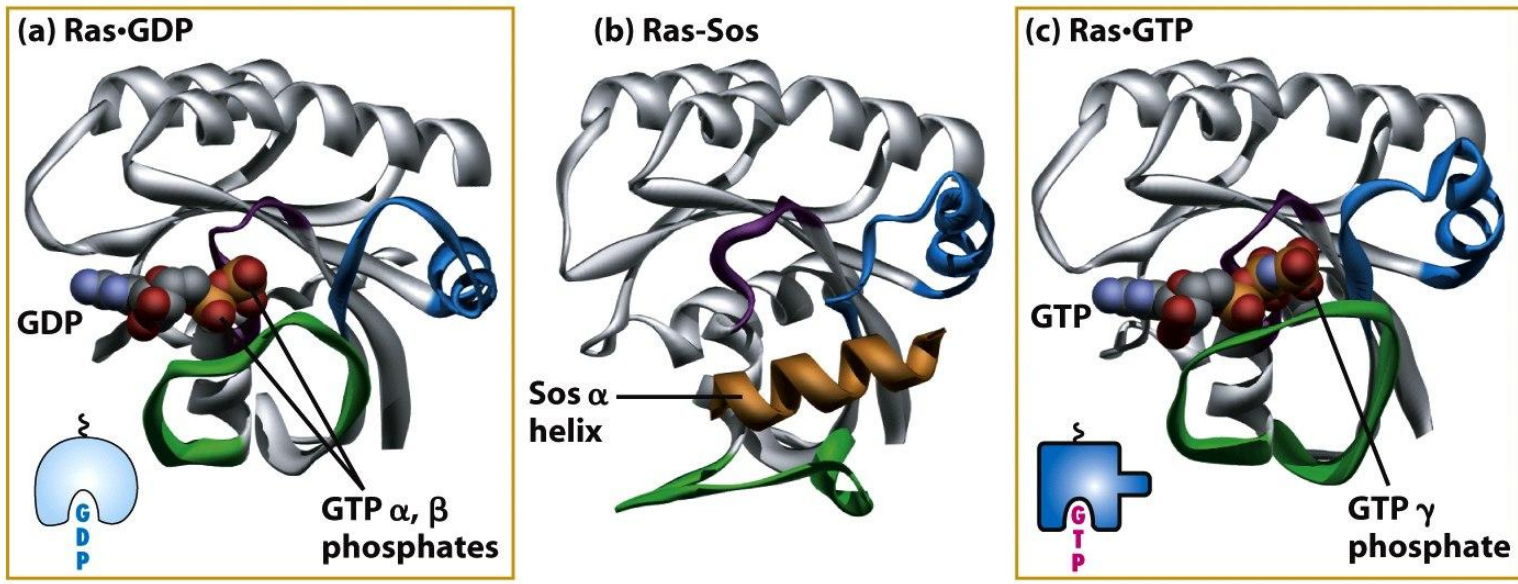
SOS → Active Ras

Figure 16-20 part 3
Molecular Cell Biology, Sixth Edition
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How does Sos Work?

(a) Ras·GDP

GDP

GTP α, β phosphates

(b) Ras-Sos

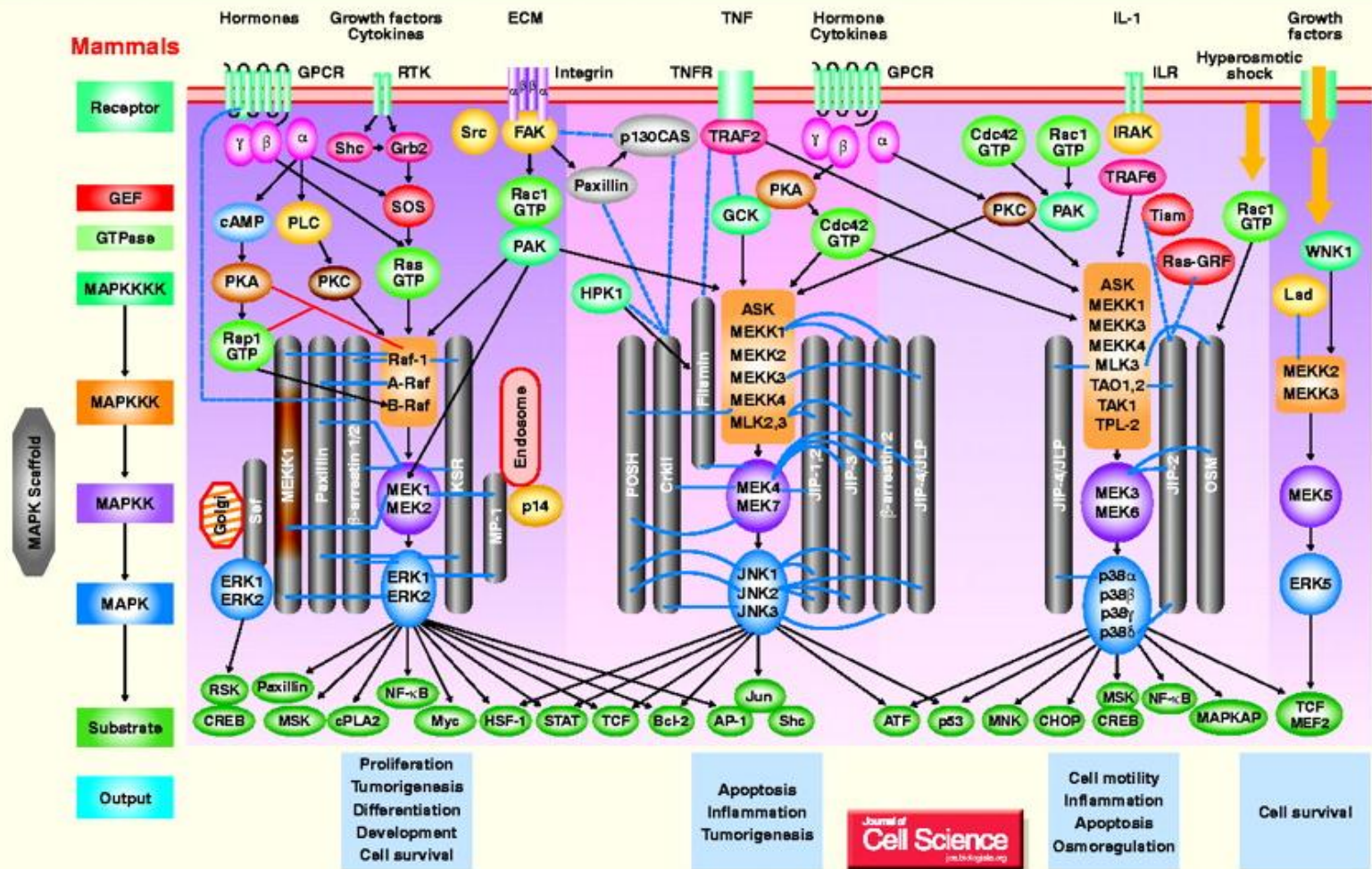Sos α helix

(c) Ras·GTP

GTP

GTP γ phosphate

Switch I
Switch II

Figure 16-24
Molecular Cell Biology, Sixth Edition
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Signaling Pathways

MAP Kinase Pathways
Maosong Qi and Elaine A. Elion

Questions?