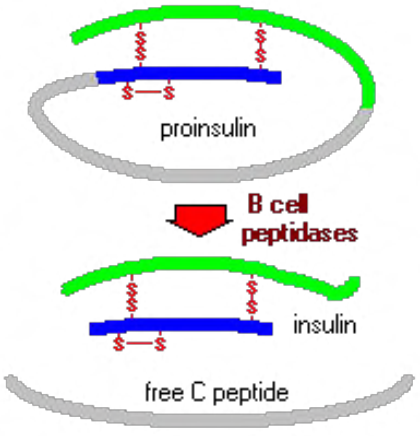
# Endocrine Functions of Pancreas

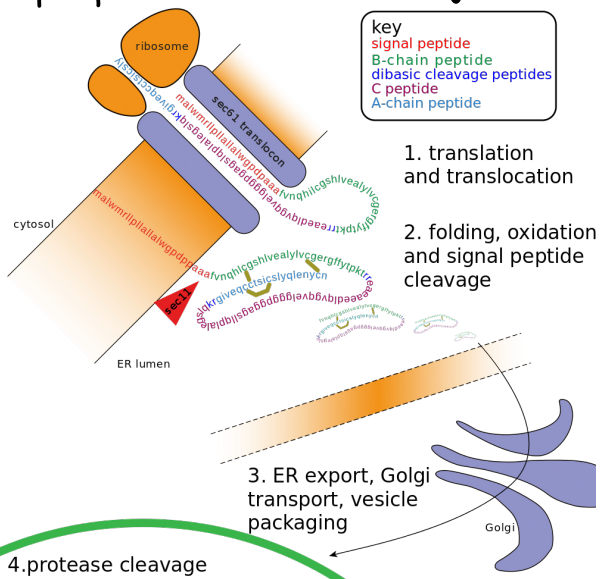
## Introduction :

- Endocrine function of Pancreas - By Islets of Langerhans.
- Human pancreas contains about 1 to 2 million islets.
- It contains **4 types** of cells :
  - (a) A cells or α-cells → Glucagon
  - (b) B cells or β-cells → Insulin
  - (c) D cells or δ-cells → Somatostatin
  - (d) F cells or PP cells → Pancreatic polypeptide.

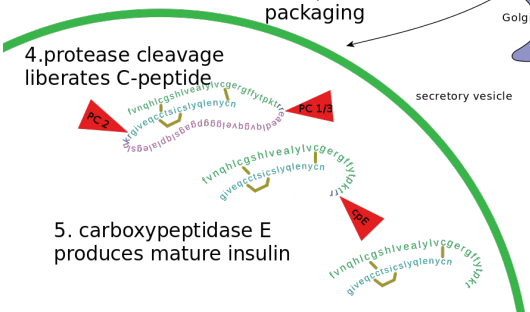
## Insulin :

- Secreted by B cells or β-cells in the islets of Langerhans.
- It is 51 AA with wt = 5808 do
- Two amino acid chains α & β linked by disulfide chains.
  21 AA 30 AA
- Half-life = 5 mins
- Basal level of insulin in plasma = 10 μU/mL
- Synthesis occurs in RER of β-cells as preproinsulin that give rise to proinsulin.




- Insulin is later degraded in liver & kidney by **Insulin protease** (or) Insulin-degrading enzyme.



# Functions of Insulin

## On Carbohydrates:

(1) It is only anti-diabetic hormone in our body.
(2) Increase transport and uptake of glucose by cells by increasing permeability of cell membrane.
(3) Promotes peripheral utilization of glucose.
(4) Promotes storage of glucose - glycogenesis
(5) Inhibits Glycogenolysis.
(6) Inhibits Gluconeogenesis

## On Protein Metabolism:

(7) Facilitates storage and synthesis of proteins and inhibits the cellular utilization.
(8) Incs. the transport of AAs into cell from blood.
(9) Inc. protein syn. by influencing translation & transcription.
(10) Preventing protein catabolism.

## On Fat Metabolism:

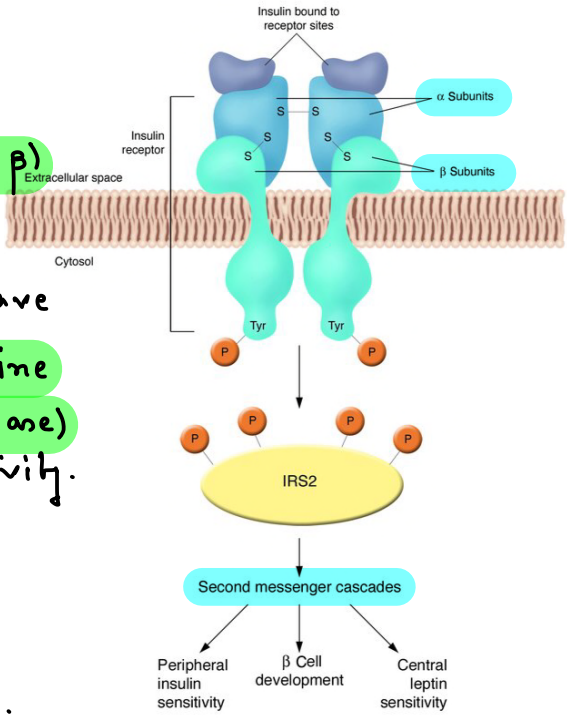
(11) Synthesis of fatty acids and triglycerides.
(12) Transport of fatty acids into adipose tissue.
(13) Storage of fat.

## On Growth:

(14) Insulin promotes growth of body by its anabolic action.
(15) It has Protein-sparing effect (Using glucose as energy and conservation of protein)

## Mode of Action :

- Insulin binds with receptor protein and forms Insulin-Receptor complex and thus executes intracellular enzyme system.
- Insulin receptor is a glycoprotein with wt. 340,000 da and present in all the cells of body.
- Insulin receptor is tetramer, formed by four glycoprotein subunits (two α & two β)
- Intracellular surfaces of α-subunits have enzyme activity – protein kinase (tyrosine kinase) activity.
- When insulin binds with α-unit the tyrosine kinase is activated by autophosphorylation.
- Later secondary messengers get activated.

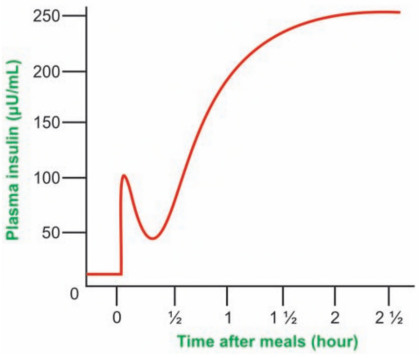



## Regulation of Insulin Secretion :

(1) **Role of Blood Glucose level** : As blood glucose ↑, insulin ↑

After meal, initially, insulin increases upto 100 μU/mL from basal level of 10 μU/mL.

- After 10-15 mins, the value ↓ to 40-50 μU/mL as all stored insulin in pancreas is used.
- After 15-20 mins, the release increases and reaches max btw 2-2.5 hrs.




- The prolonged increase is due to formation of new insulin molecules from pancreas.

(2) Role of Proteins : Excess AAs in blood stimulates insulin secretion.

- Potent amino acids are Arginine and lysin.

(3) Role of Lipid Derivatives : The β-ketoacids (acetoacetate) also increase insulin secretion.

(4) Role of Gastrointestinal Hormones : Gastrin, Secretin, CCK & GIP all increase Insulin secretion.

(5) Role of Endocrine Hormones : Diabetogenic hormones indirectly increases insulin secretion.

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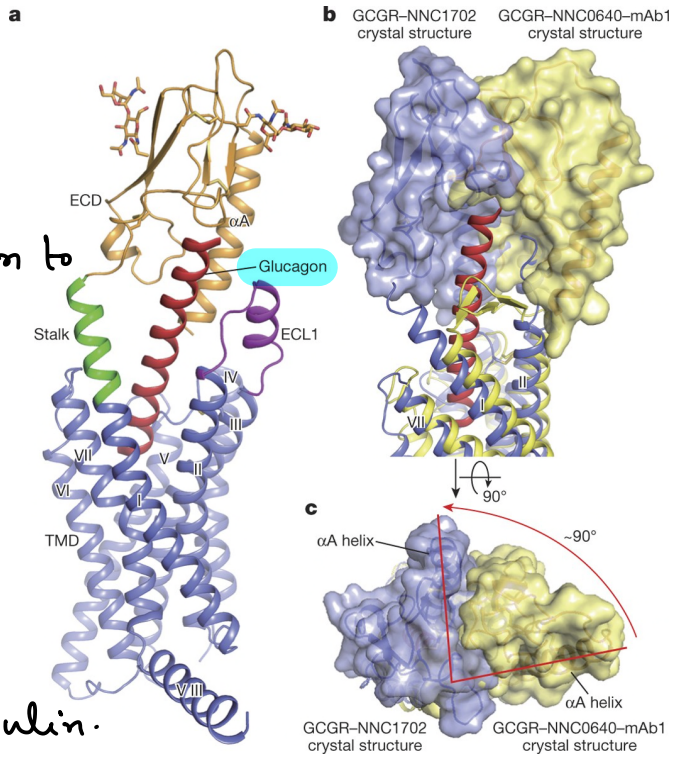
Glucagon
Growth hormone
Cortisol

(6) Role of Autonomic Nerves :

- Stimulation of Parasym (Vagus) increases insulin secretion via Acetylcholine.
- Sympathetic inhibits insulin secretion via Norodrenaline.

## Glucagon

- Glucagon is secreted from A cells or α-cells in Islets of Langerhans.
- It is also secreted from A cells of stomach and L. cells of Intestine.
- It is 29 AAs wt = 3,485 da
- Half-life = 3-6 mins.
- Synthesized from Preproglucagon which turns to proglucagon then to glucagon.
- About 30% is degraded in liver.
  20% in Kidney
  50% in blood itself




## Functions :

- Its function is antagonist to Insulin.

On Carbohydrates

(1) Inc. glycogenolysis in Live

(2) Release glucose from liver.

(3) Increase gluconeogenesis.

On Protein metabolism:

(4) Glucagon increases transport of AA into liver for Gluconeogenesis.

On Fat

(5) It shows lipolytic and ketogenic actions.

(6) It inhibits Gastric juice secretions and inc. bile secretion.

## Mode of Action :

- On target cells (mostly liver), glucagon combines with receptor & activates adenyl cyclase via G-protein.

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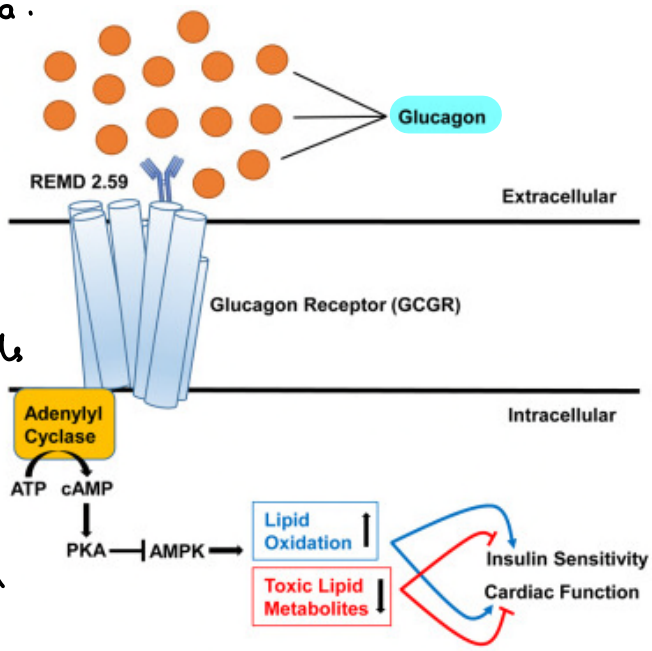
  Formation of AMP which brings out Actions of Glucagon.

- Glucagon Receptor (peptide) = 62,000 da.




## Regulation of Glucagon Secretion

(1) Role of Blood Glucose

When Glucose < 80 mg/dl, α-cells are stimulated and more glucagon is released.

(2) Role of AA : AA ↑ , Glucagon sec. ↑

(3) Other factors :

Increase secretion

(i) Exercise
(ii) Stress
(iii) Gastrin
(iv) CCK
(v) Cortisol

Inhibit Secretion

(i) Somatostatin
(ii) Insulin
(iii) FFA
(iv) Ketones

| Features | Insulin | Glucagon |
|---|---|---|
| Source of secretion | β-cells of islets of langerhans | α-cells of islets of langerhans |
| Action on carbohydrate metabolism | *Decreases blood glucose level by:*<br>1. Facilitating transport and uptake of glucose by all cells except liver cells<br>2. Increasing peripheral utilization of glucose<br>3. Increasing glycogenesis in liver and muscle<br>4. Preventing glycogenolysis<br>5. Preventing gluconeogenesis | *Increases blood glucose level by:*<br>1. Facilitating glucose transport into liver cells<br>2. Increasing glycogenolysis<br>3. Increasing gluconeogenesis |
| Action on protein metabolism | 1. Facilitates amino acid transport<br>2. Accelerates protein synthesis<br>3. Prevents protein catabolism<br>4. Prevents conversion of proteins into glucose | 1. Increases transport of amino acids into liver cells<br>2. Increases utilization of amino acids for gluconeogenesis |
| Action on fat metabolism | 1. Increases synthesis and storage of fat<br>2. No ketogenic effect | 1. Increases lipolysis<br>2. Promotes ketogenesis |
| Blood fatty acids | Decreases | Increases |
| Hypersecretion leads to | Hypoglycemia | Hyperglycemia |
| Hyposecretion leads to | Diabetes mellitus | Hypoglycemia |