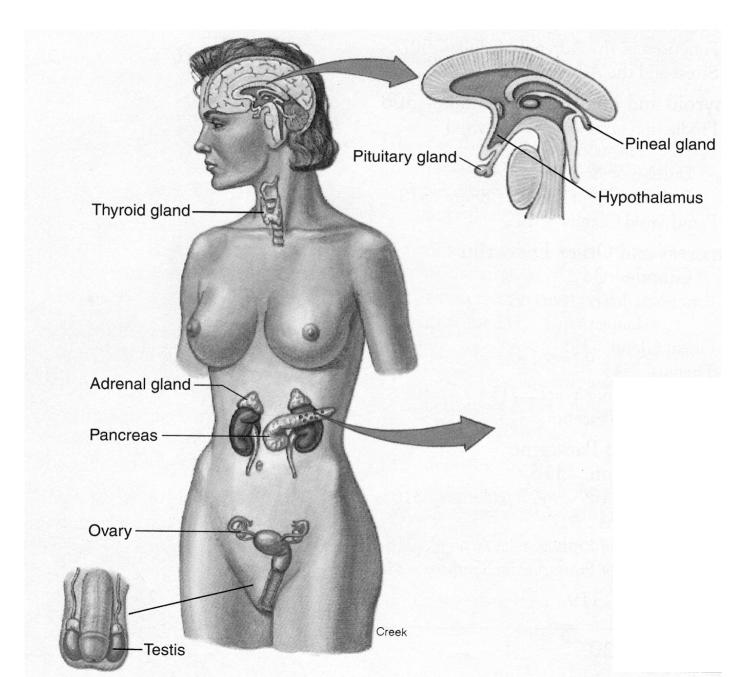
Endocrine Glands and the General Principles of Hormone Action

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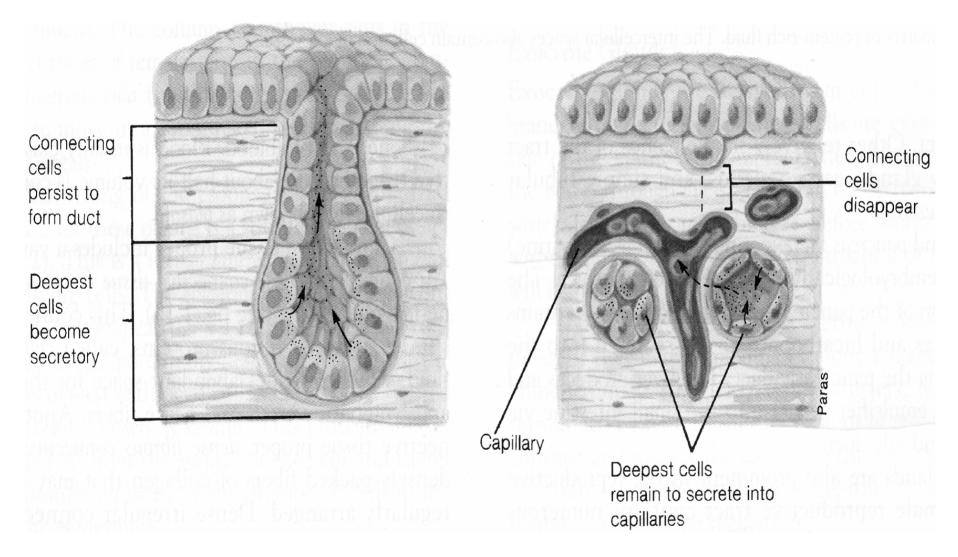
"Classical" Endocrine Glands



A more complete listing of the endocrine glands

Endocrine gland	Major hormones	Primary target organs
Adipose tissue	Leptin	hypothalamus
Adrenal cortex	Glucocorticoids	liver, muscle
	Aldosterone	kidneys
Adrenal medulla	Epinephrine	heart, blood vessels
Heart	Atrial natriuretic hormones	kidneys
Hypothalamus	Releasing and inhibiting hormones	pituitary
Small intestine	Secretin, cholecystokinin	stomach, liver, pancreas
Islets of Langerhans	Insulin	fat, muscle, brain
	glucagon	liver, fat
Kidneys	erythropoietin	bone marrow
Liver	Somatomedins	cartilage
Ovaries	estradiol, progesterone	repro. tract, mammary glands
Parathyroid glands	Parathyroid hormone	bone, small intestine, kidneys
Pineal gland	Melatonin	hypothalamus, ant. Pituitary
Pituitary, anterior	Trophic hormones	endocrine glands
Pituitary,posterior	Antidiuretic hormone	kidney, blood vessels
	oxytocin	uterus, mammary glands
Skin	1,25-dihydroxy vitamin D ₃	small intestine
Stomach	Gastrin	Stomach
Testes	Testosterone	prostate, seminal vesicles
Thymus	Thymosin	lymph nodes
Throid gland	T3, T4, calcitonin	Many

Exocrine and Endocrine Glands



Exocrine Glands and Endocrine glands

Exocrine Glands:	Secrete into a duct and to the outside of a body surface	
Examples:	sweat, tear, saliva	
<u>Endocrine Glands:</u>	Secrete (hormone) into the blood Hormone circulates in blood and acts at target organs where hormone receptor is expressed	
Examples:	insulin	

Exocrine and Endocrine glands:

	Endocrine	Exocrine
Liver:	IGF	Bile
Pancreas	Pancreatic juice	insulin, glucagon, PP

Chemical Structure of Hormones

1. Amines (amino acid derivatives)

Tyrosine derived: epinephrine, thyroid hormones Tryptophan derived: melatonin

2. Polypeptides

Insulin, leptin, ADH

3. Glycoproteins

FSH, LH

4. Steroids (cholesterol derived)

Glucocorticoids, testosterone, vitamine D

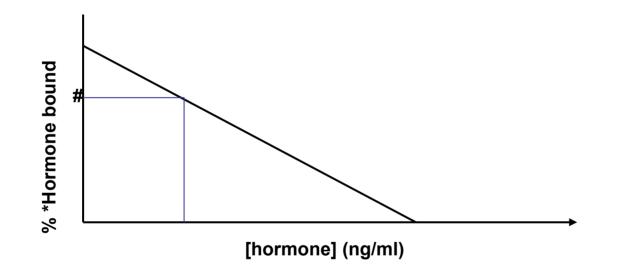
Mechanisms of Actions of Hormones

All hormones act by binding to their receptors

- Some receptors are located on the <u>cell surface</u>
 - Polar hormones (insulin, leptin)
 - Some receptors are located in the cytoplasm
 - Lipophilic hormones (steroids, thyroid hormones)
 - Some receptors are located in the <u>nucleus</u>
 - Lipophilic hormones (TZDs, Fibrates)

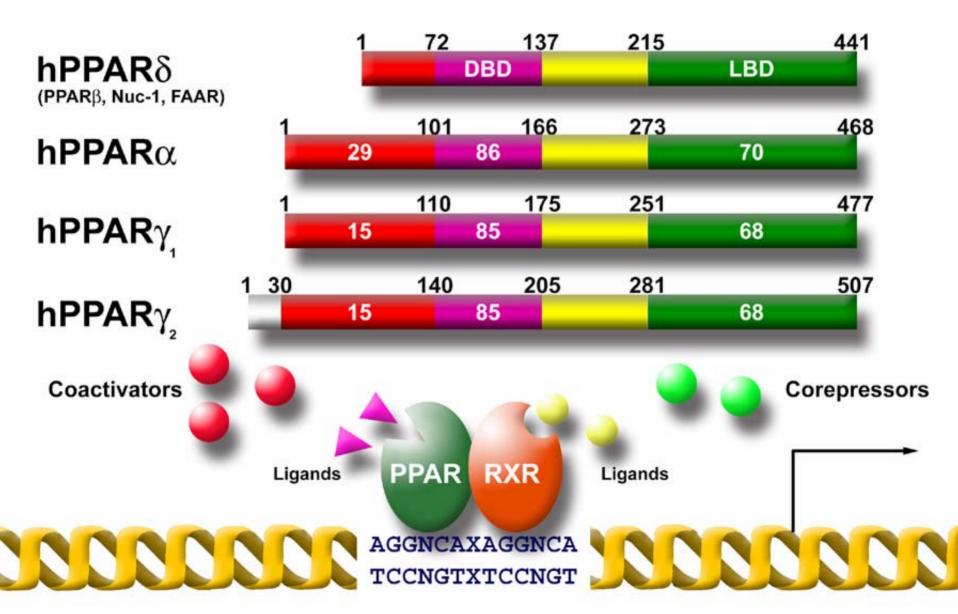
Assay and Measurement of Hormones

Bioassay Chemical assay Radioimmunoassay (1977 Nobel prize)

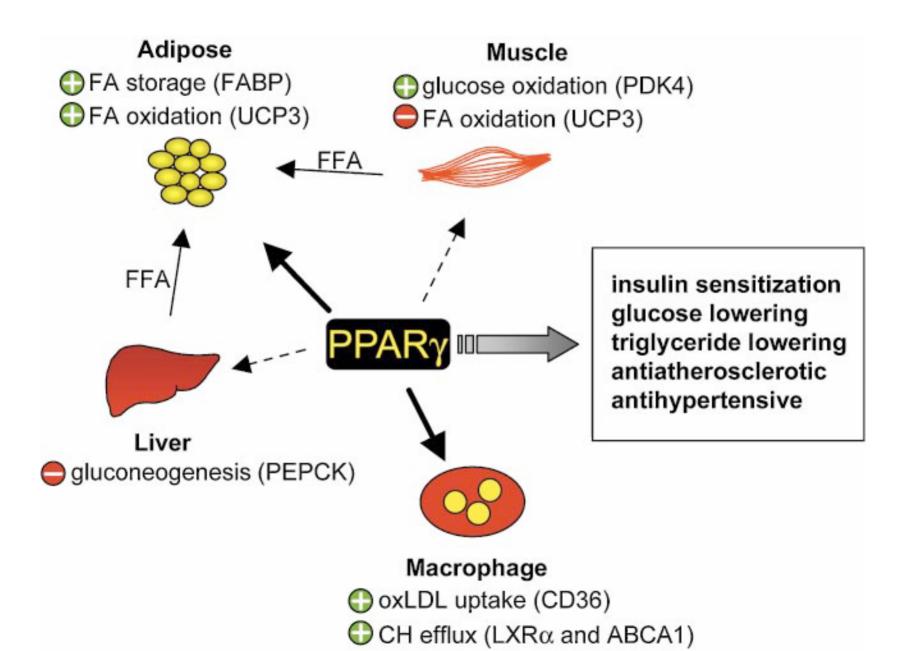


Receptor binding assay (Scatchard plot)

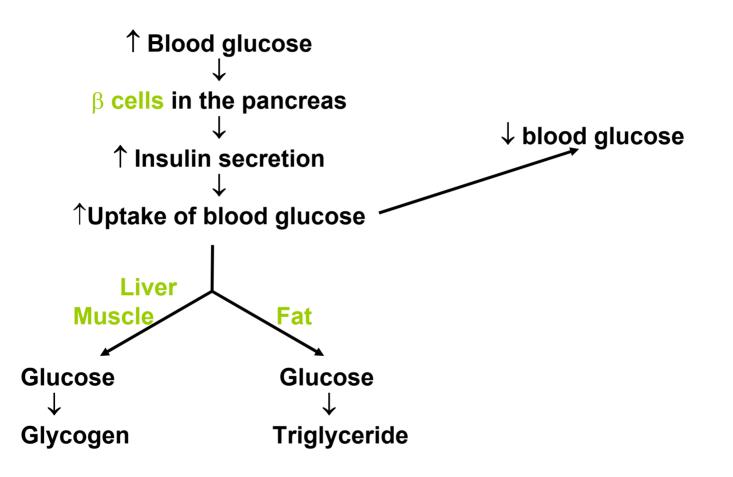
Action of nuclear hormones



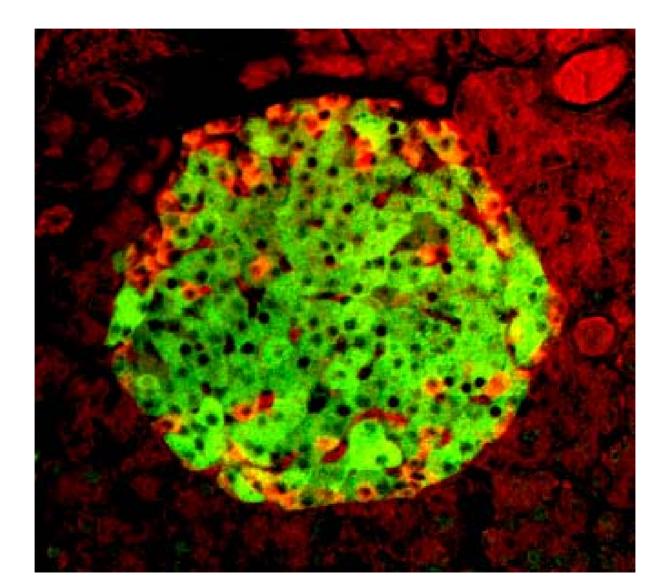
Actions of PPAR γ , a nuclear hormone receptor



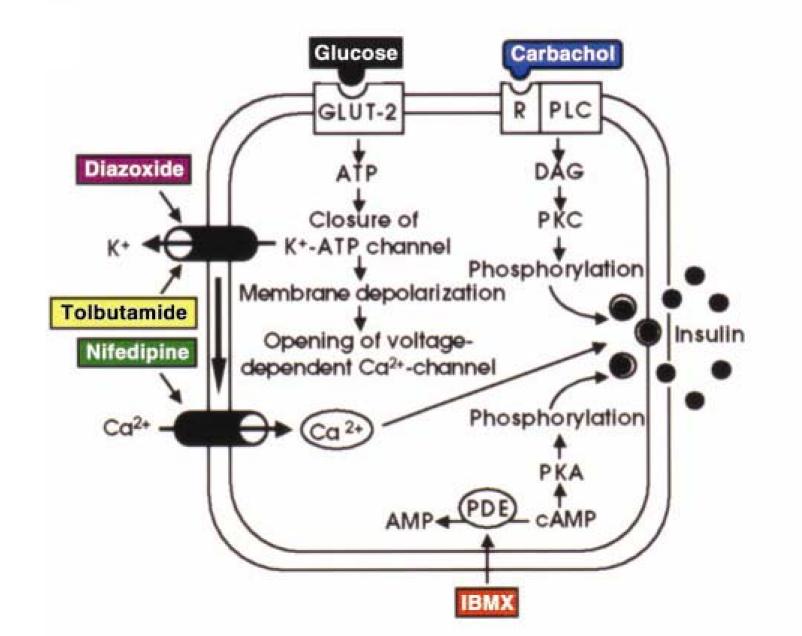
Regulation of hormone secretion: A simple feedback loop



Structure of an islet



How glucose and therapeutic drugs cause insulin secretion



Two general principles of hormone action

Acts on cells containing the receptor

Action is regulated by a feedback mechanism

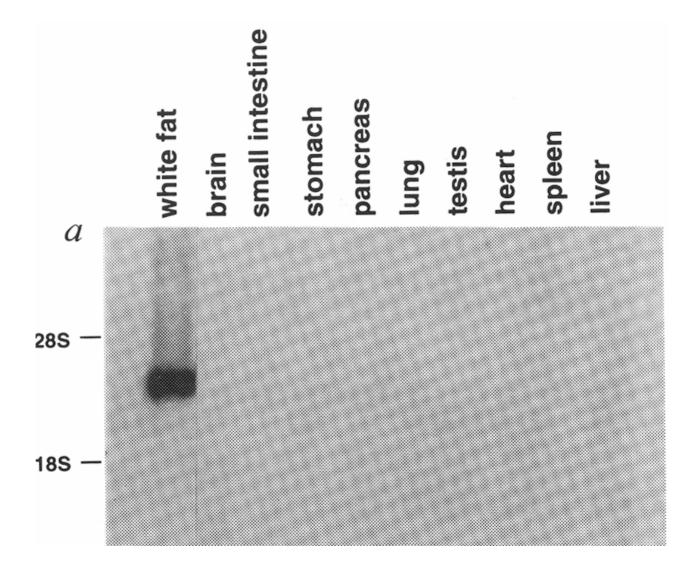
Overweight and NIDDM in the U.S. ?

1980 1990 2000 2010

Leptin: a new hormone from fat

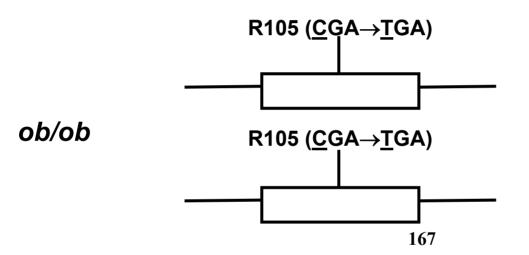
- Made in the adipose tissues
- •A polypeptide of 167 amino acids
- Product is secreted into blood
- Its receptor is found in many tissues
- Leptin deficiency causes obesity, infertility, and many other
 complications

Tissue distribution of leptin

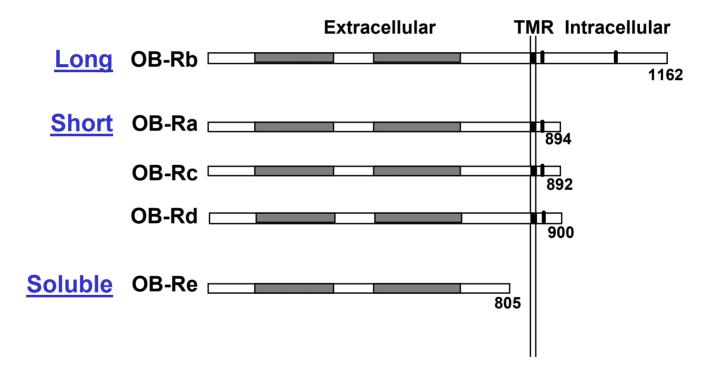




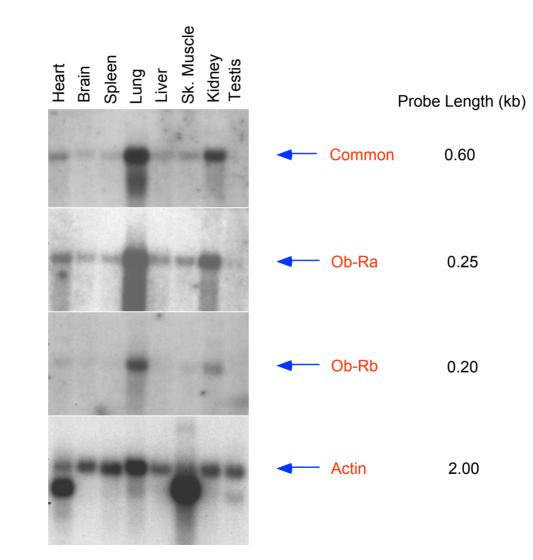
Leptin gene mutation in ob/ob mouse



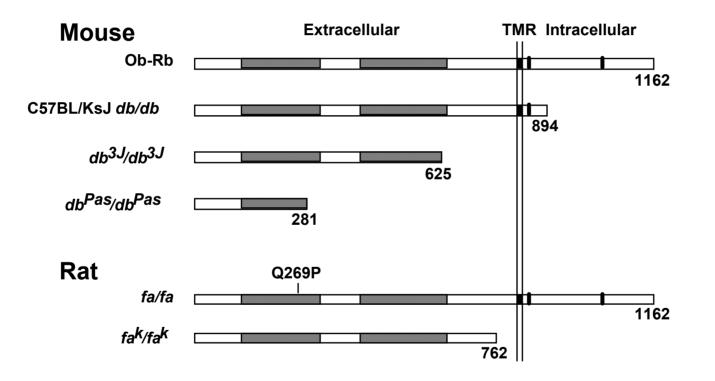
Leptin Receptor Isoforms



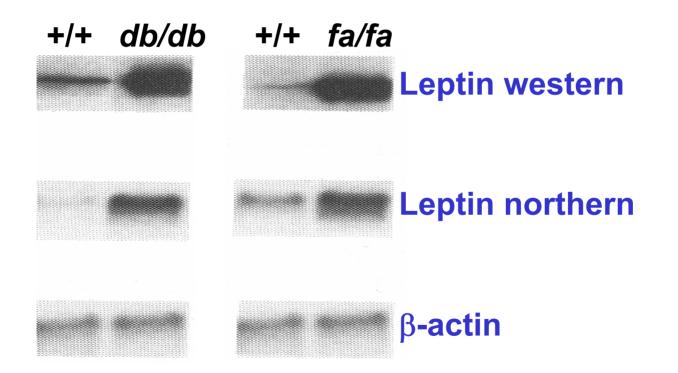
Tissue distribution of the leptin receptor



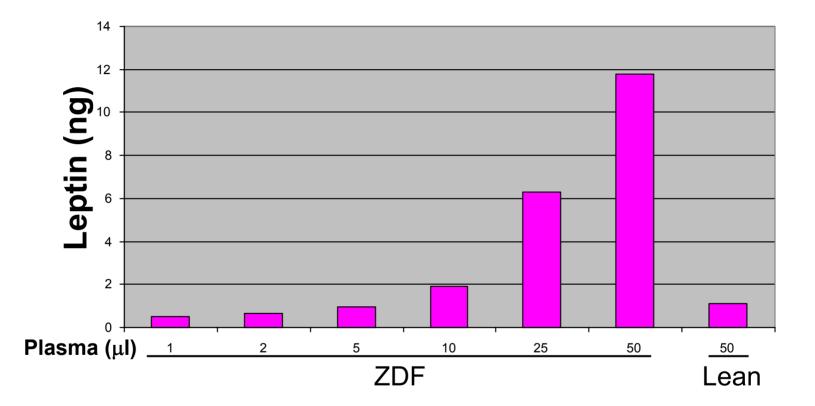
Rodent Mutations at the db Locus



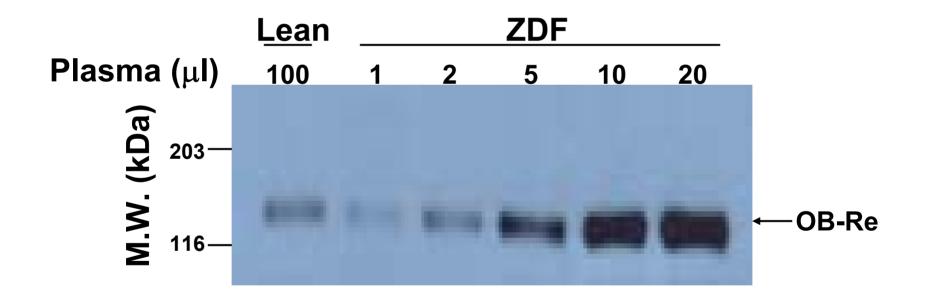
Leptin Levels in Lean and Obese Rodents



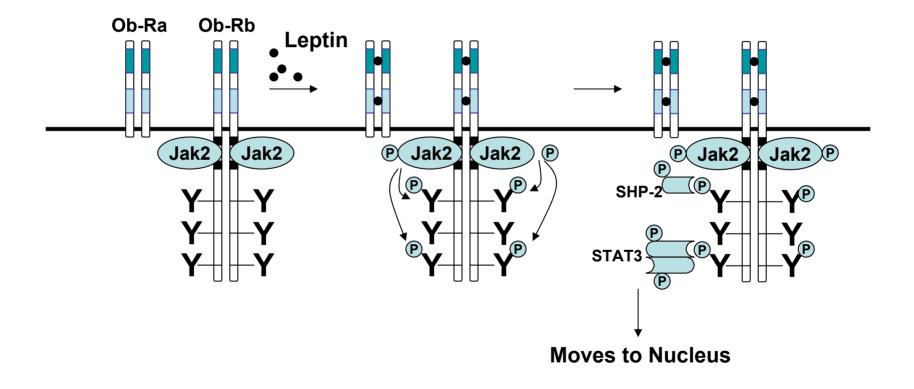
Leptin levels in lean and ZDF rats



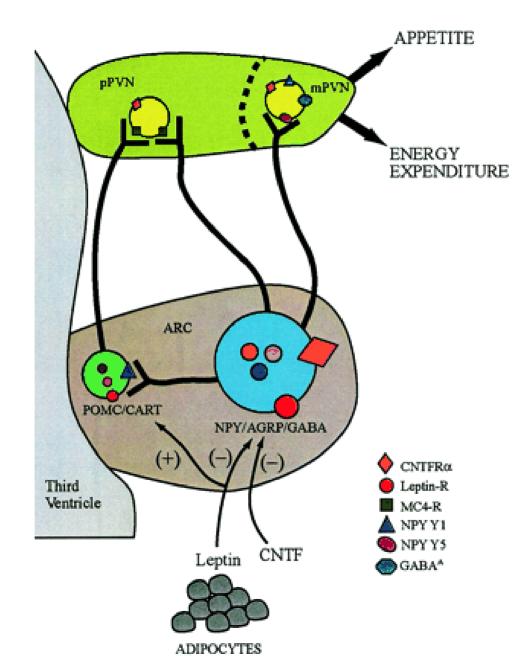
Soluble Leptin Receptor Levels in Lean and ZDF Rats

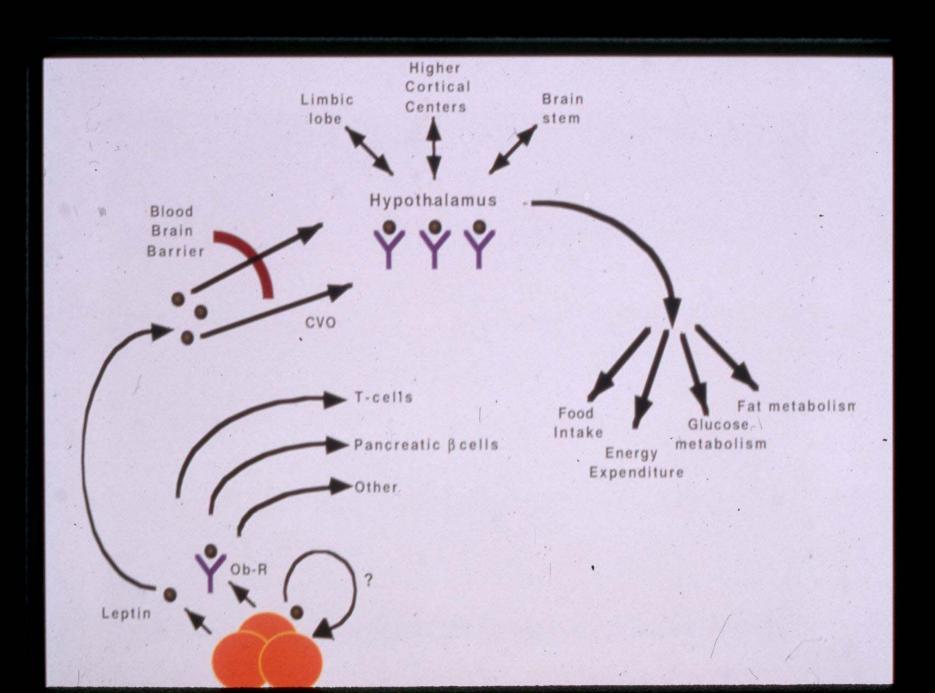


Jak-STAT Pathway of Leptin Receptor Signal Transduction

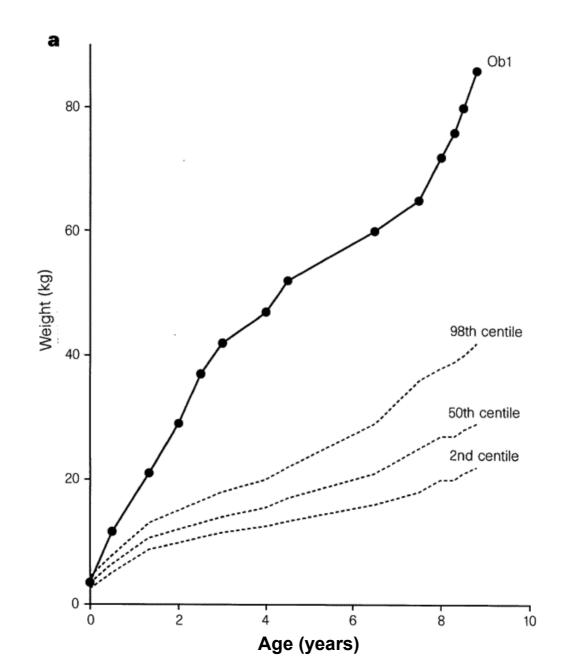


Hypothalamic signaling pathways regulating energy homeostasis

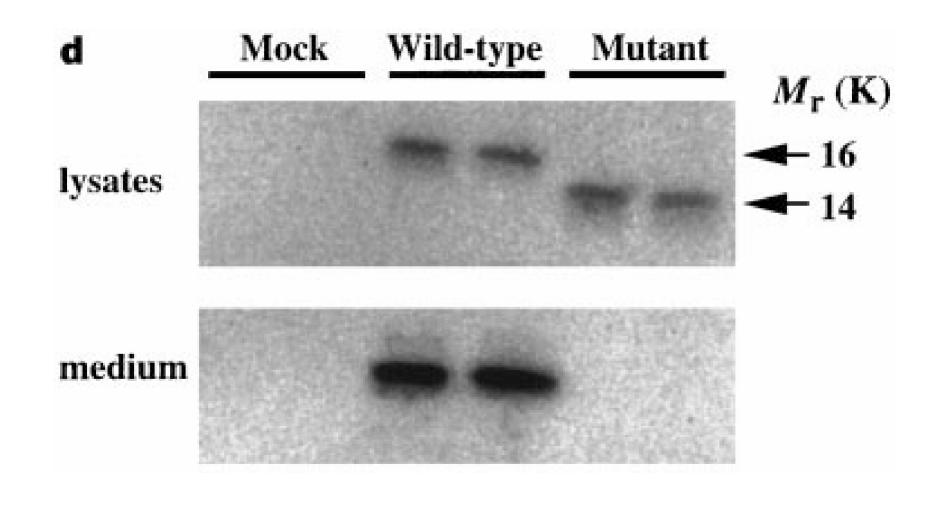




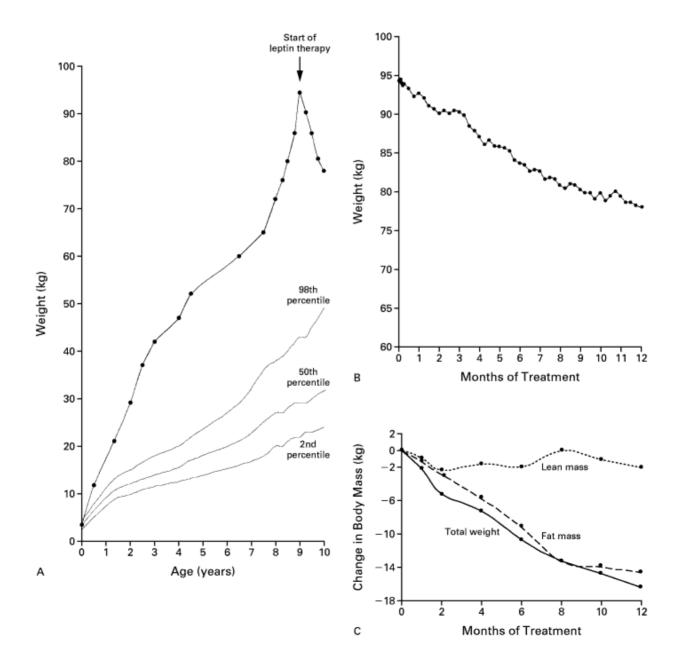
Severe postnatal obesity of a child with leptin mutation



One example of human leptin mutation



Leptin treatment of a girl with leptin deficiency



SUMMARY

- Most tissues are endocrine glands and have the capacity to secrete molecules that act on other tissues
- All hormones act by interaction with their receptors
- The action of most hormones are regulated by a negative feedback mechanism