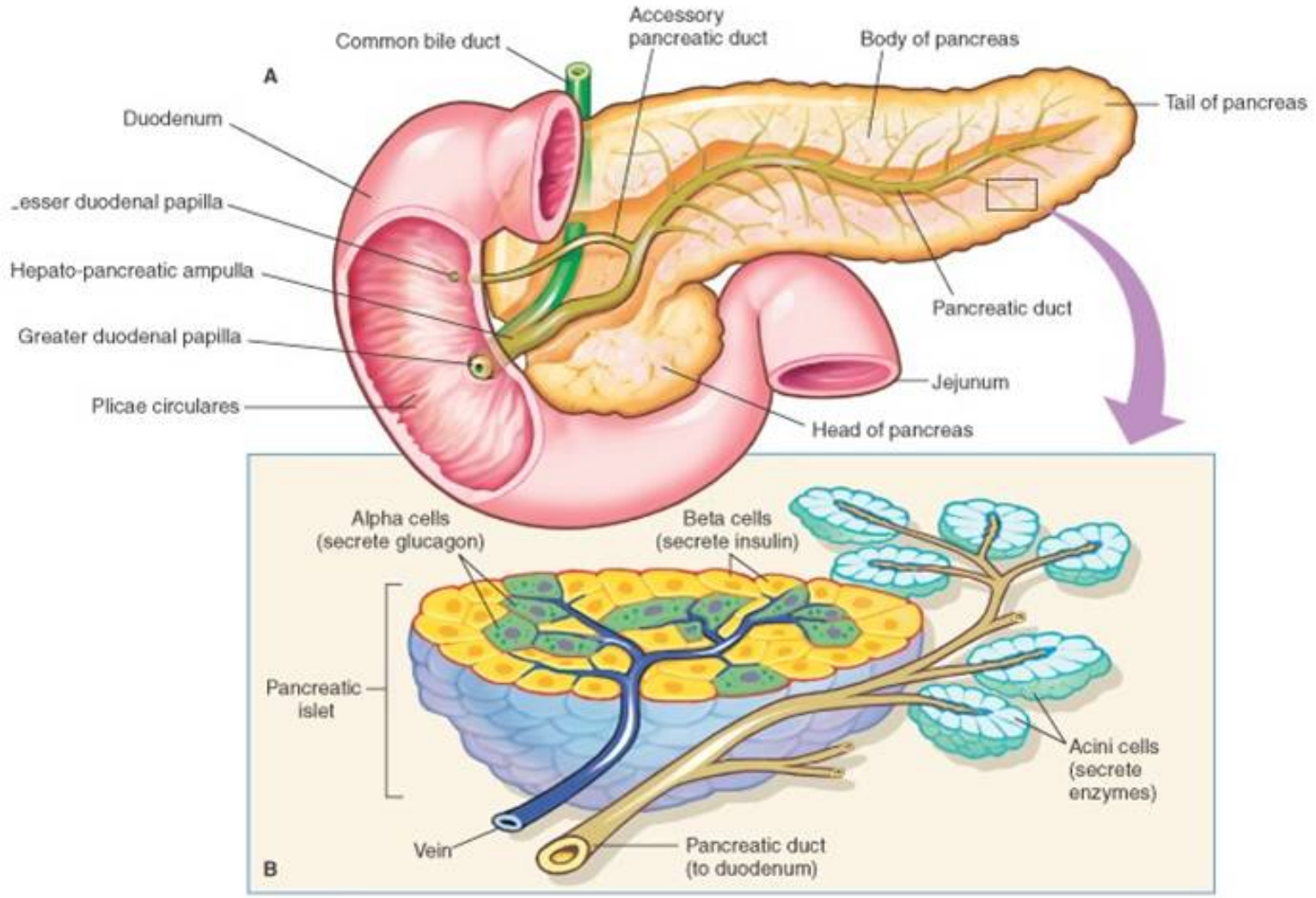
PANCREAS


A
Common bile duct
Accessory pancreatic duct
Body of pancreas
Tail of pancreas
Duodenum
Lesser duodenal papilla
Hepato-pancreatic ampulla
Greater duodenal papilla
Plicae circulares
Pancreatic duct
Jejunum
Head of pancreas
Alpha cells (secrete glucagon)
Beta cells (secrete insulin)
Pancreatic islet
Acini cells (secrete enzymes)
Vein
Pancreatic duct (to duodenum)
B

REGOLAZIONE DEL GLUCOSIO

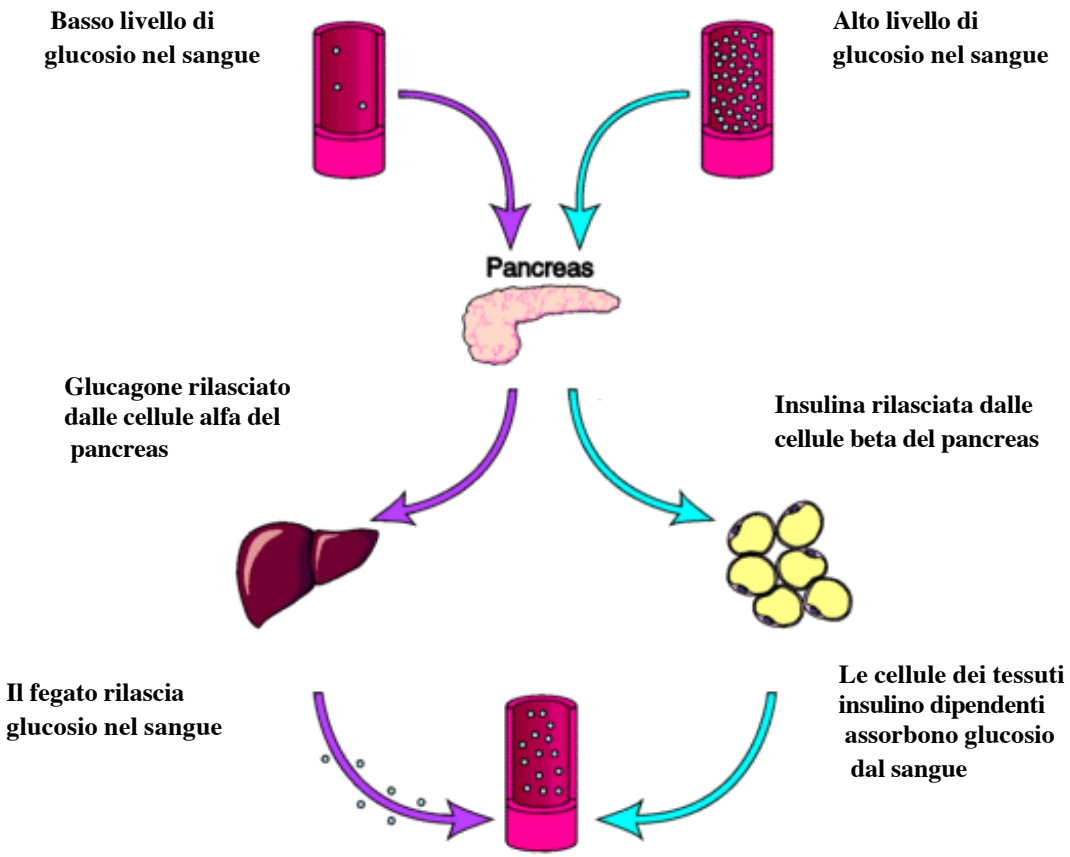


Figura 4: il controllo del glucosio

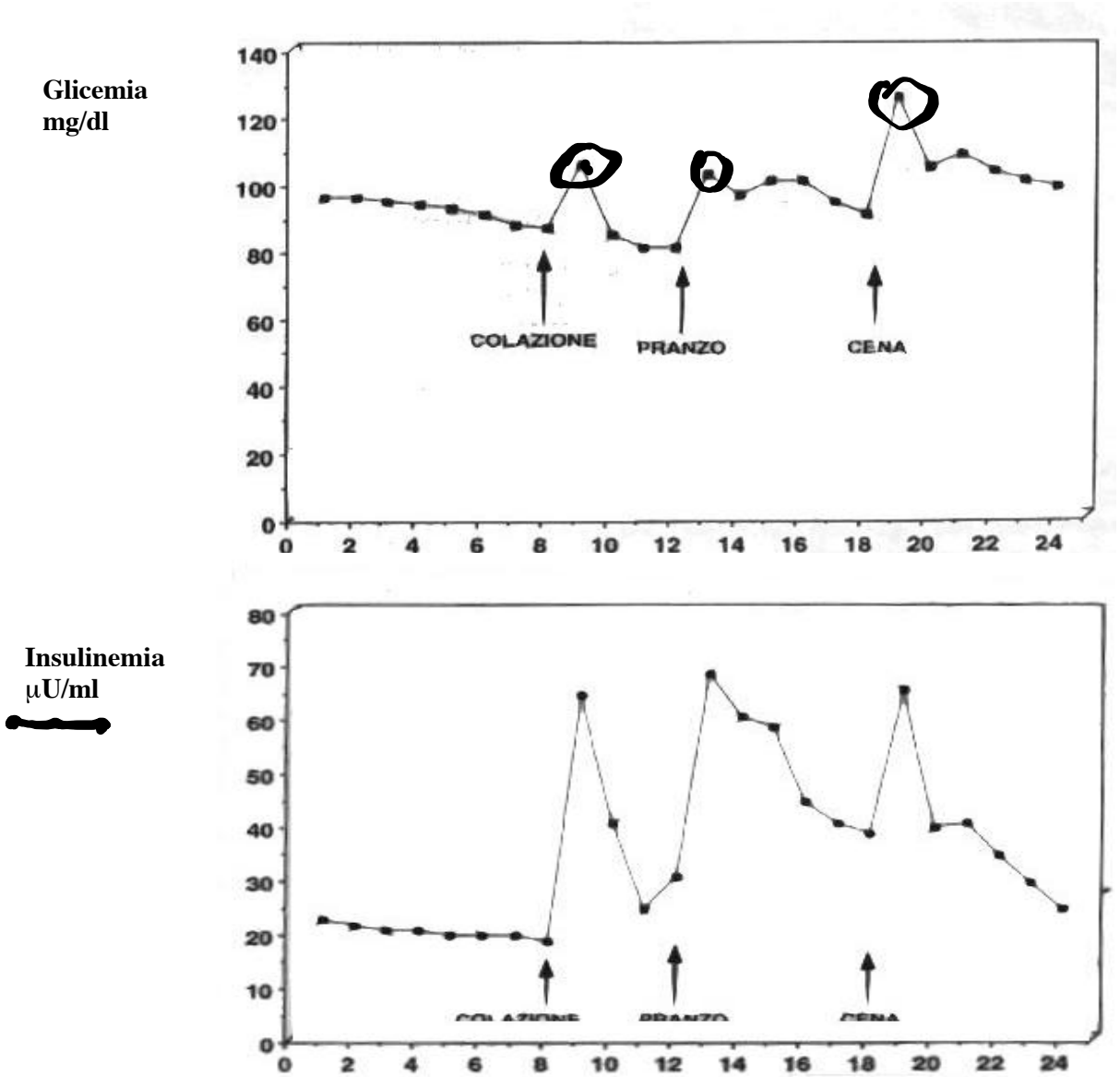


Figura 6: escursioni giornaliere di glicemia e insulinemia

SECREZIONE INSULINICA

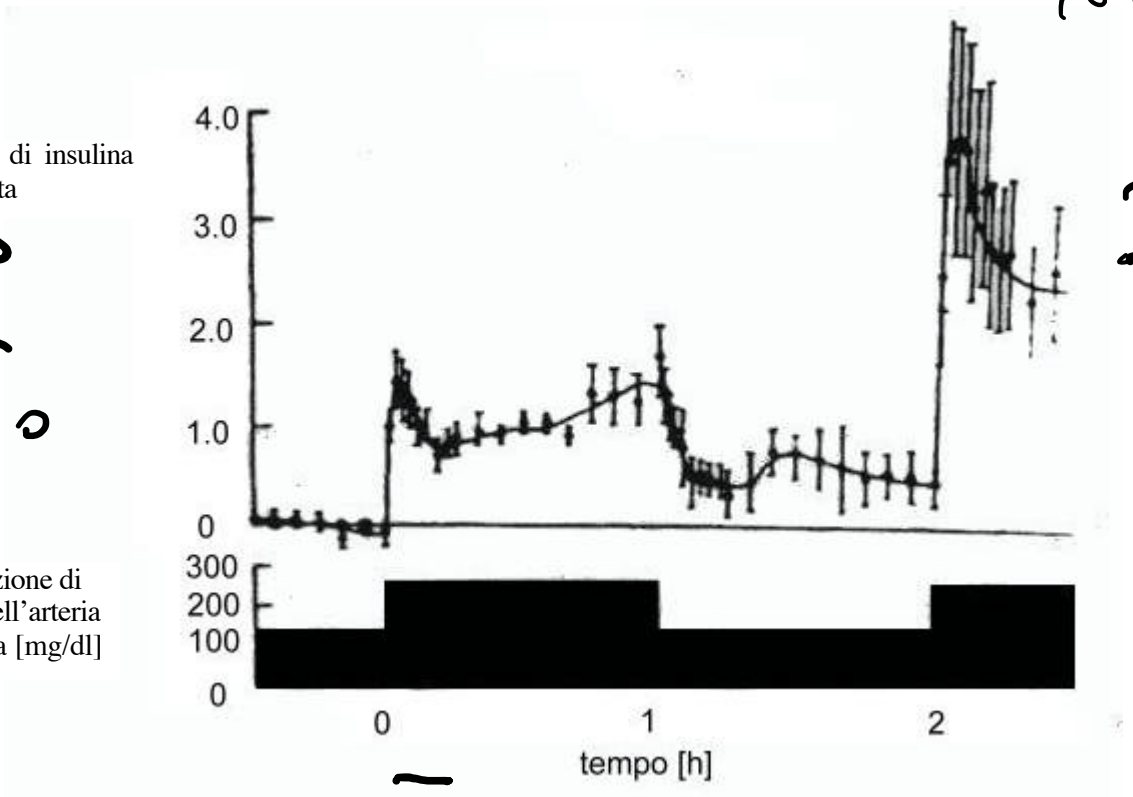
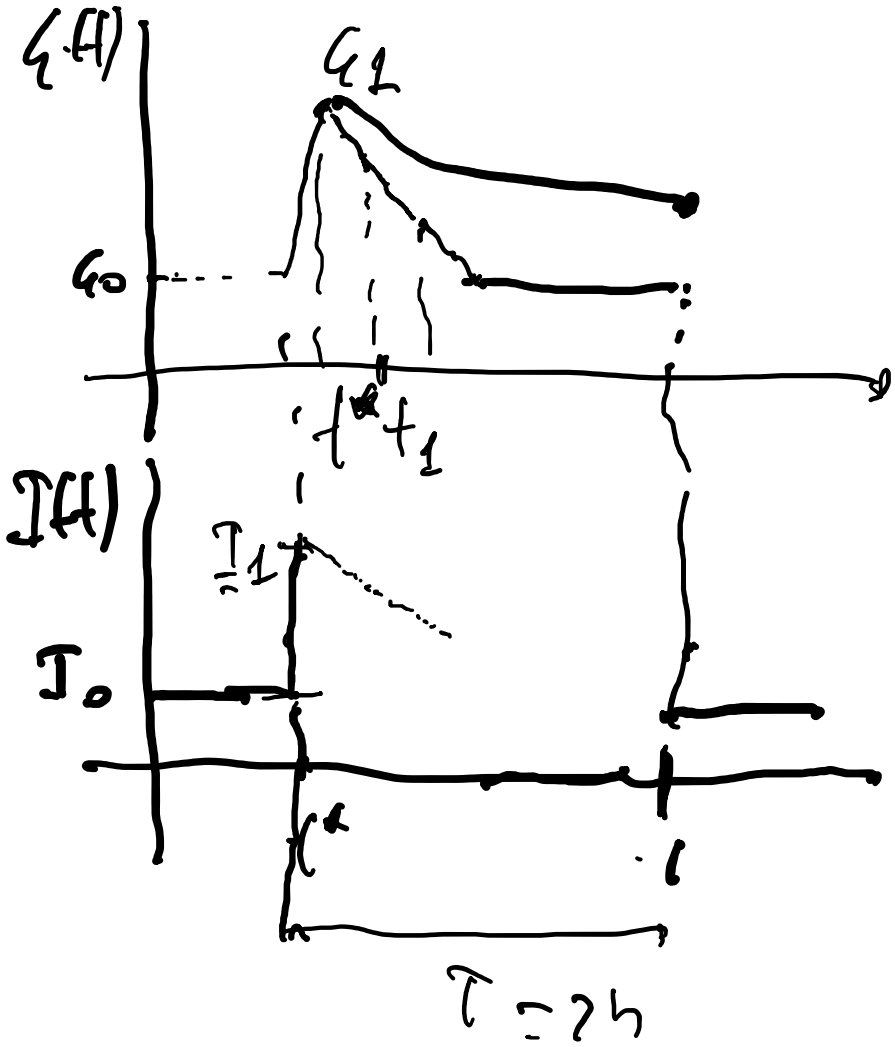


Figura 7.Risposta delle beta cellule a uno stimolo a gradini di glucosio

TABELLA 1.
Criteri per la diagnosi di diabete mellito indicati dall'ADA nelle raccomandazioni 2009

Criterio	Note
Glicemia a digiuno (*fasting plasma glucose,* FPG) ≥126 mg/dl (7,0 mmol/l)	Il digiuno è definito dall'assenza di assunzione di cibo nelle precedenti 8 ore
Sintomi di iperglicemia e riscontro casuale di valori di glucosio plasmatico ≥200 mg/dl (11,1 mmol/l)	La casualità corrisponde al dosaggio in qualunque momento della giornata senza tenere in considerazione il tempo trascorso dal pasto I sintomi classici di iperglicemia sono poliuria, polidipsia e calo ponderale non altrimenti spiegato
Valori di glucosio plasmatico ≥200 mg/dl (11,1 mmol/l) a 2 ore dalla prova da carico (test di tolleranza al glucosio orale [*oral glucose tolerance test*, OGTT])	In base alle indicazioni OMS, il test deve essere eseguito con un carico di glucosio contenente un equivalente di 75 g di glucosio anidro dissolti in acqua

Modificata da American Diabetes Association Practical Recommendations. *Diabetes Care* 2009;32(Suppl 1):S6-S12.



$\phi(t^*) = \phi_1$

$\phi(t^* + t_1) = \phi_1 - \frac{1}{4}\phi_1$

$t_1' - t^* = 15\ min$

$\phi(\hat{t}) \simeq \phi_0$

$I(t^*) = I_1 =$

$I(t^* + t_1') = I_1 - \frac{1}{4} I_1$

$\Delta I = 2\ \mu s$ $\quad \Delta I\{4h\} = 8\ \mu s$

$\Delta I\{2h\} = 4\ \mu s.$

PANCREAS ARTIFICIALE

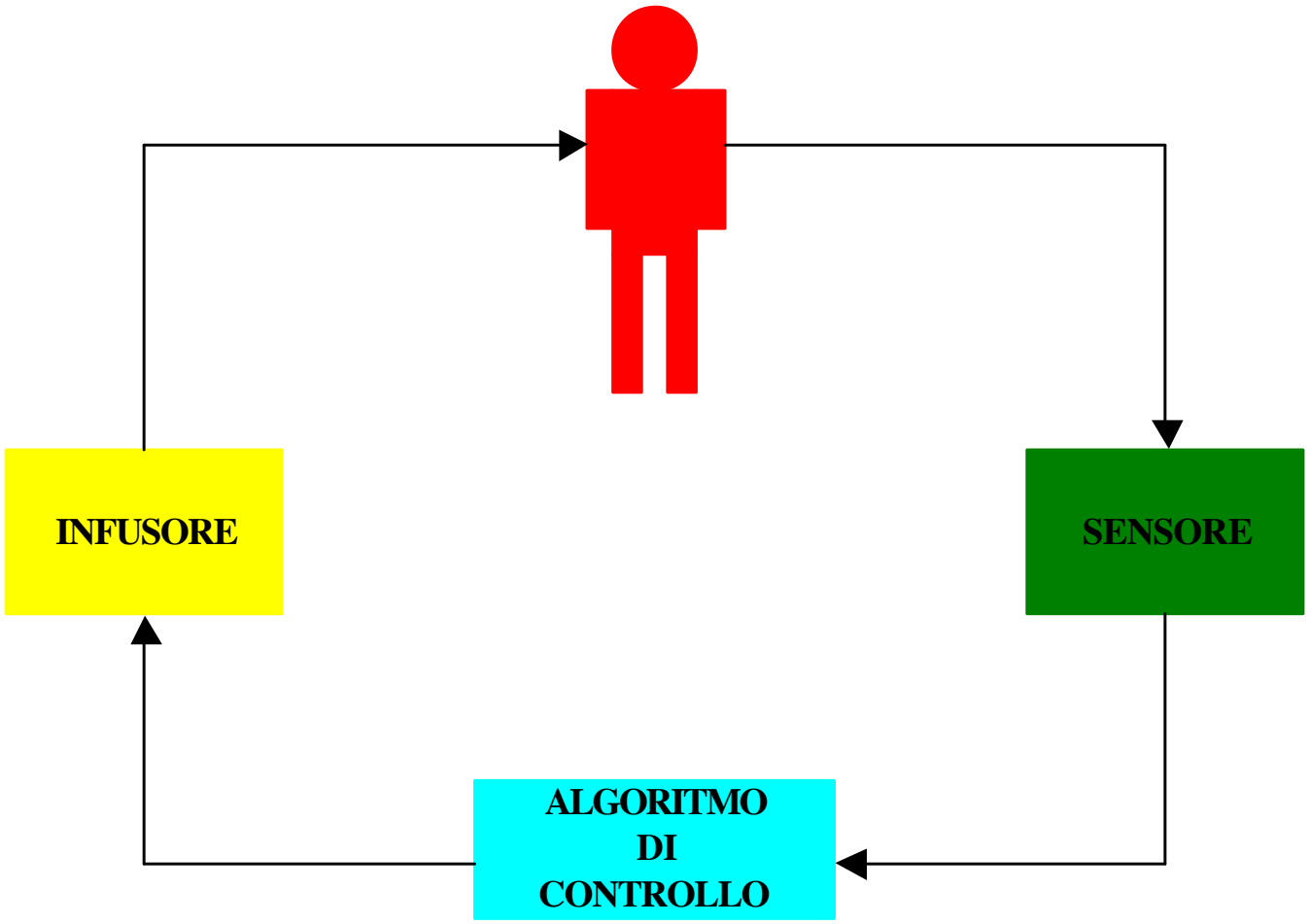
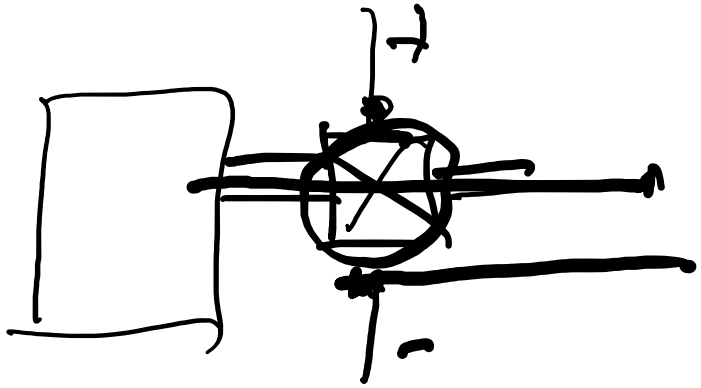
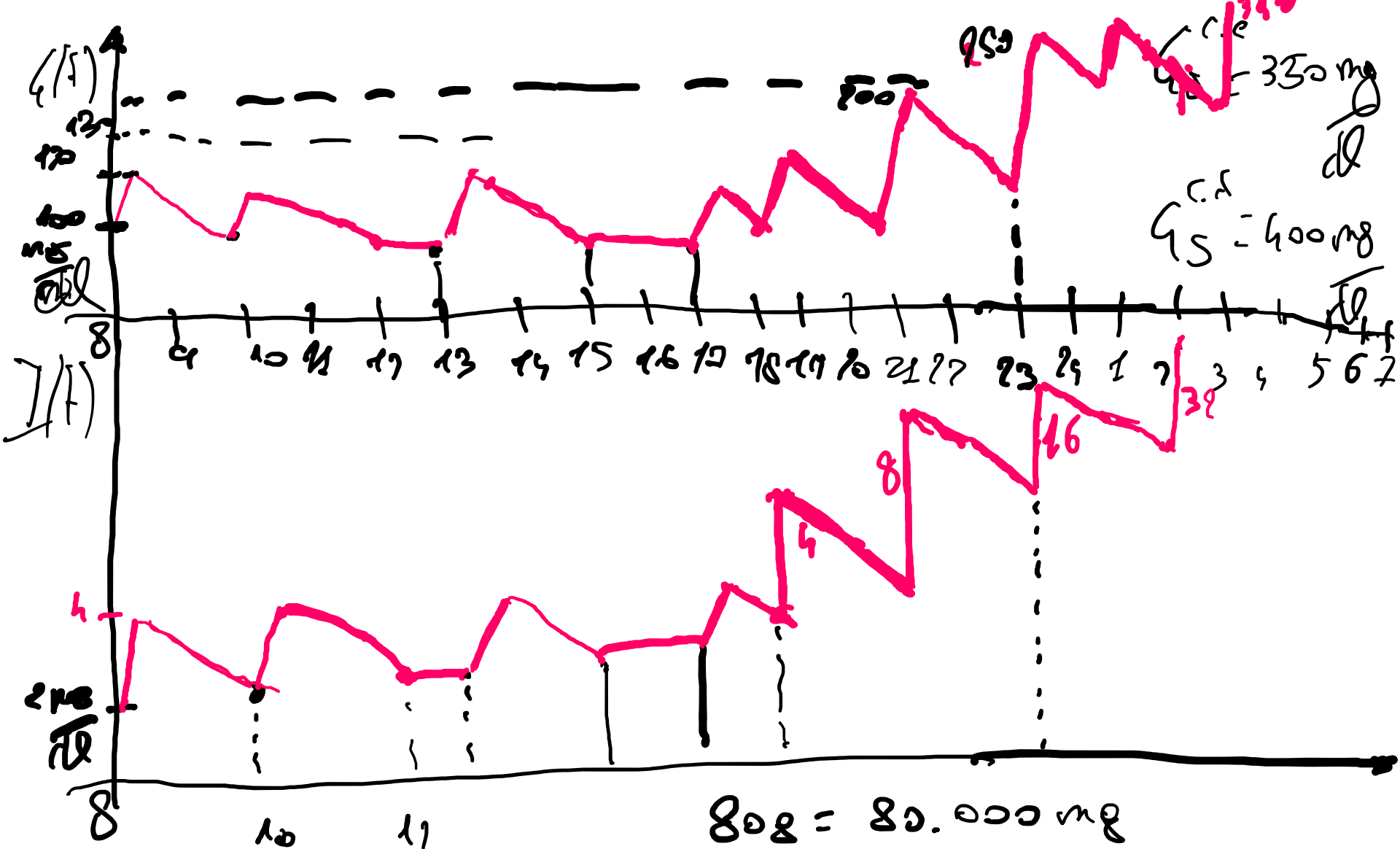


Figura 9: schema di principio di un pancreas artificiale

$$G(f) \supset 100\ \frac{mg}{Hl} \rightarrow I(f)$$



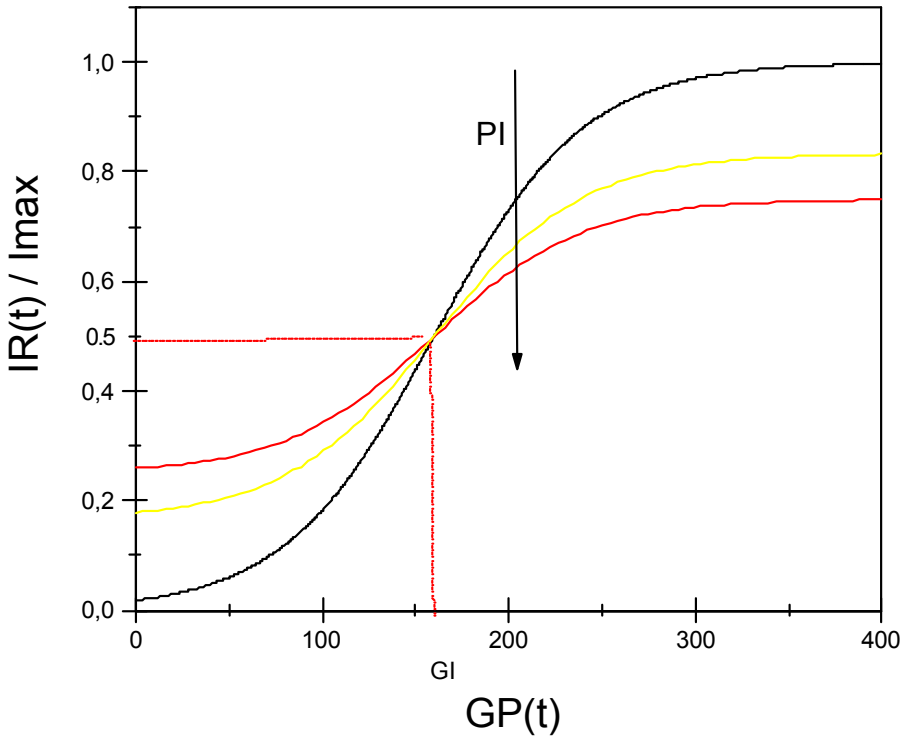


$$80g = 80.000\ mg$$

$$C(1) = \frac{80.000}{5000} = 16\ \frac{mg}{dl}$$

$$C(H) = 20\ \frac{mg}{dl}$$

Algoritmo di controllo del pancreas artificiale di Albisser



$$IR(t) = \frac{I_{max}}{2}\left[1+\tanh\frac{GP(t)-GI}{PI}\right]$$

$$GI = \sum_{i=1}^{5}\frac{G(t-i)}{5}$$

$$DR(t) = \frac{D_{max}}{2}\left[1+\tanh\frac{GP(t)-GD}{PD}\right]$$

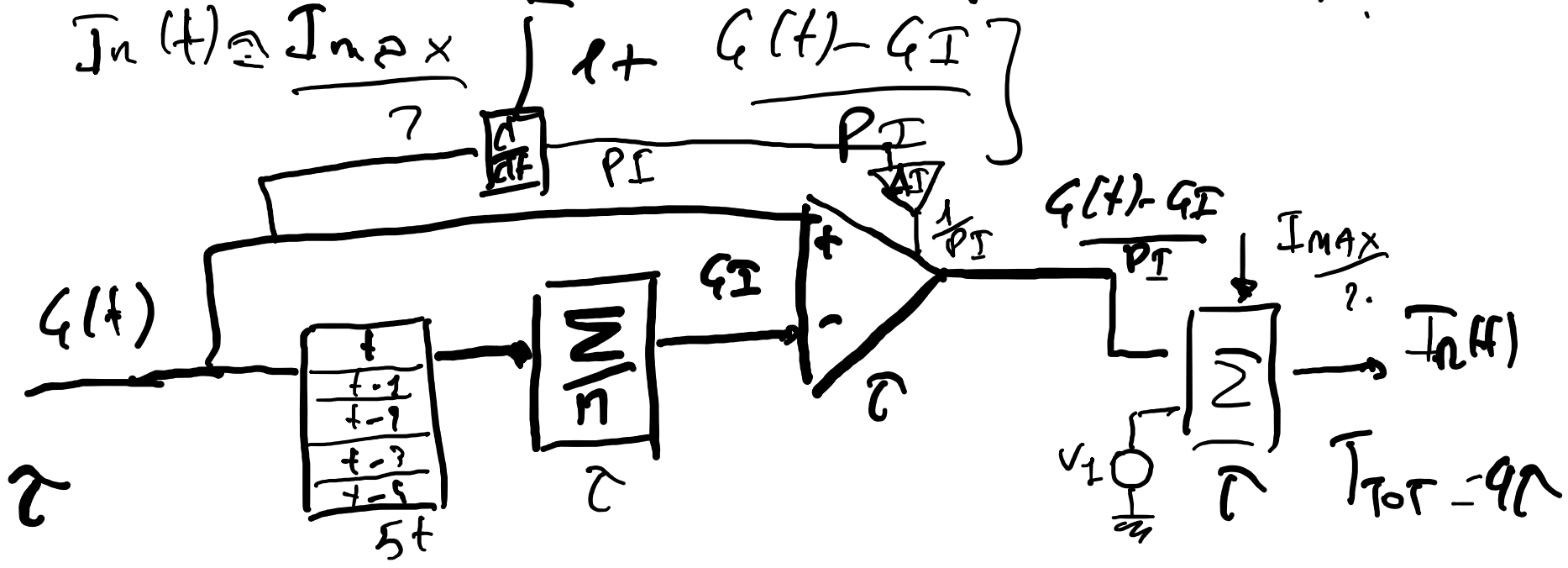
Figura 19: caratteristica di controllo del pancreas di Albisser

$$I_n(t) = \frac{I_{max}}{2}\left[1 + \tanh\frac{G(t) - G_I}{P_I}\right]$$

$$\tanh x = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} = \frac{1+x-(1-x)}{1+x+1-x} = \frac{2x}{2} = x.$$

Limite è variazioni non superiori al 3%.

$$I_n(t) \cong \frac{I_{max}}{2}\left[1 + \frac{G(t) - G_I}{P_I}\right]$$



Algoritmo di Clemens: il Biostator

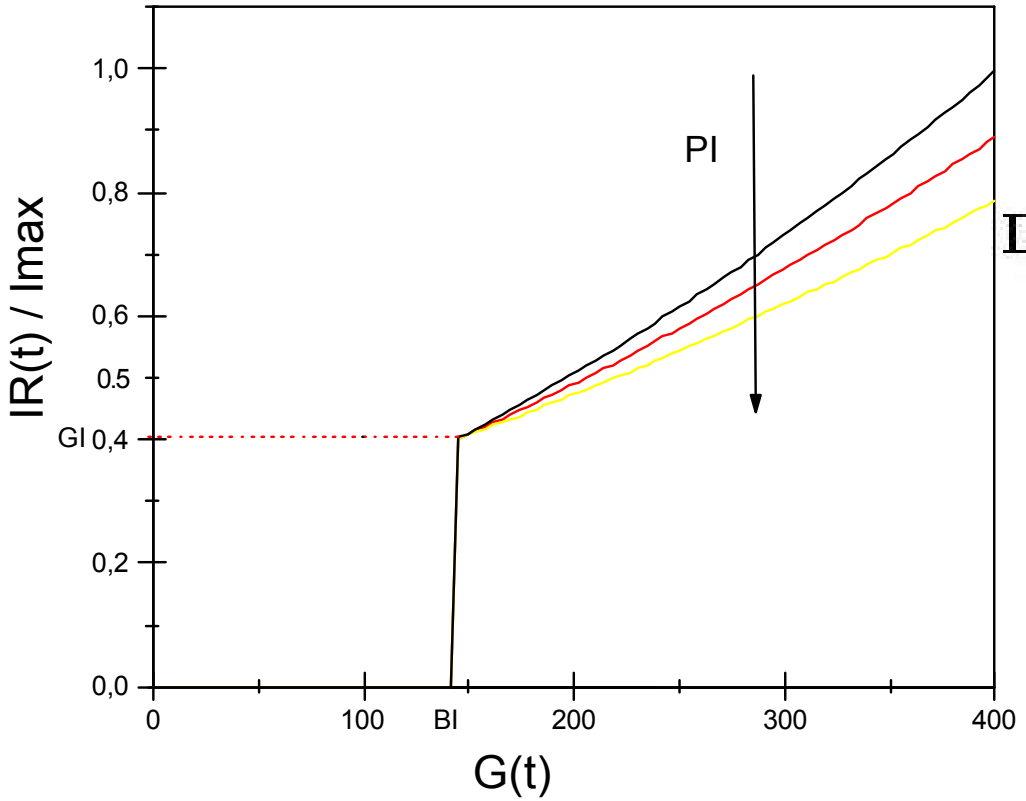


Figura 20: Caratteristica statica del Biostator

Controllo statico

$$IR(t) = RI \left[1 + \frac{G(t) - BI}{QI} \right]^2$$

Controllo dinamico

$$IR(t) = K \, dG/dt$$

BI = 100 mg/dl

Clemens

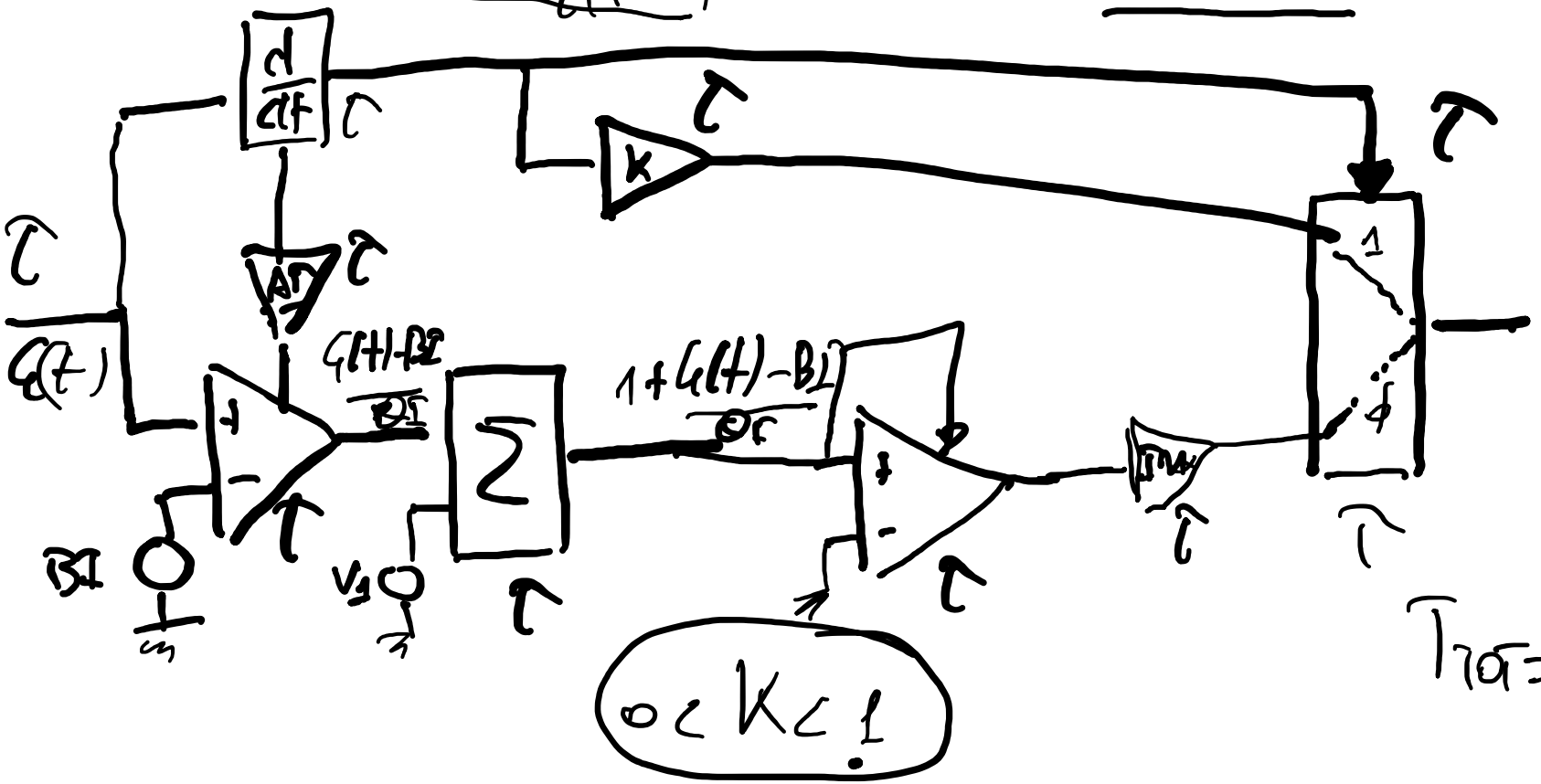
st. $I_n(t) = I_{max}\left[1 + \frac{g(t) - BI}{\Theta I}\right]$

$K_S = 7C$

$K_D = 3C$

dyn. $I_R(t) = k\frac{dg}{dt}$

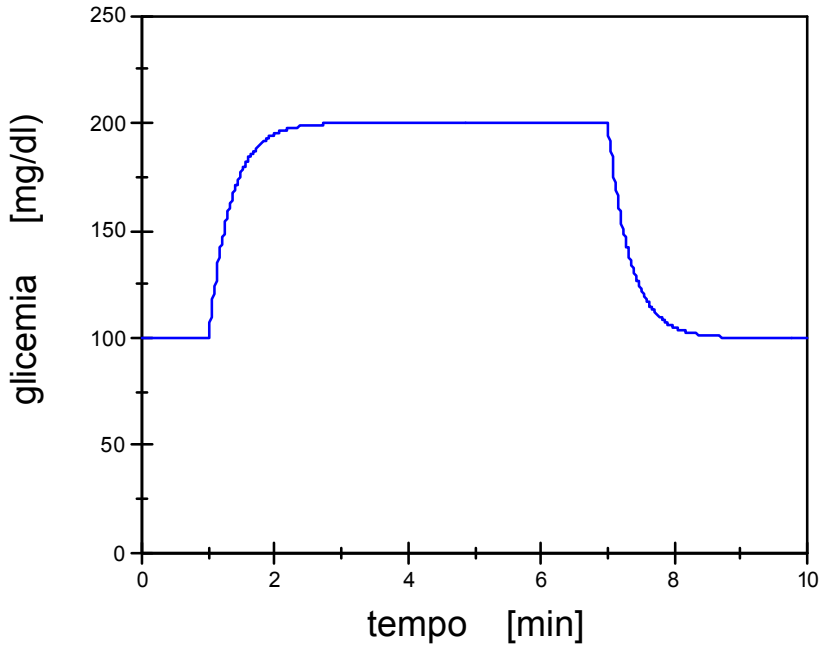
$K > 1$



$T_{TOT} = 8C$

Algoritmo di controllo di Fisher

$$IR(t) = a_0 + a_1(G\text{-}BI) + a_2\,(dG/dt)$$



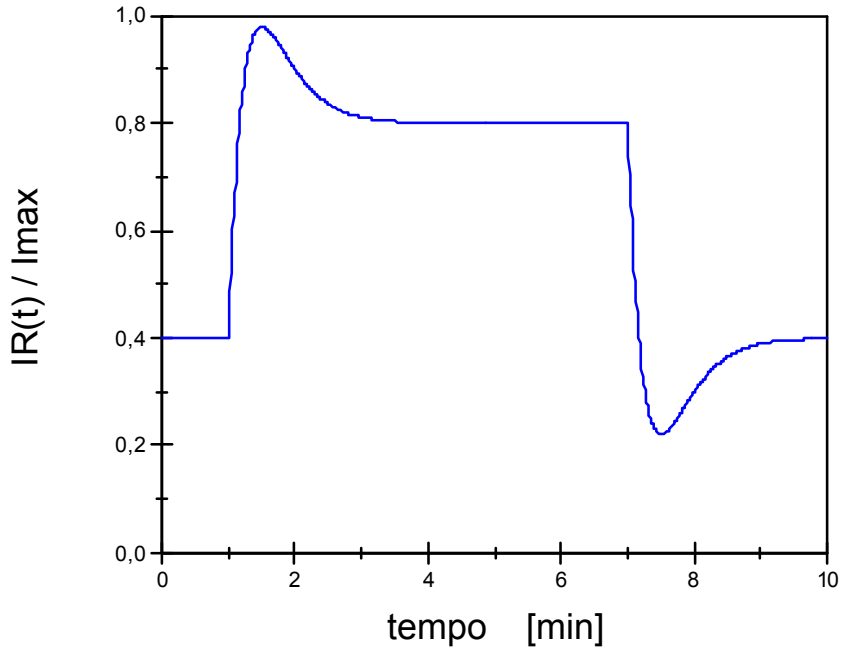
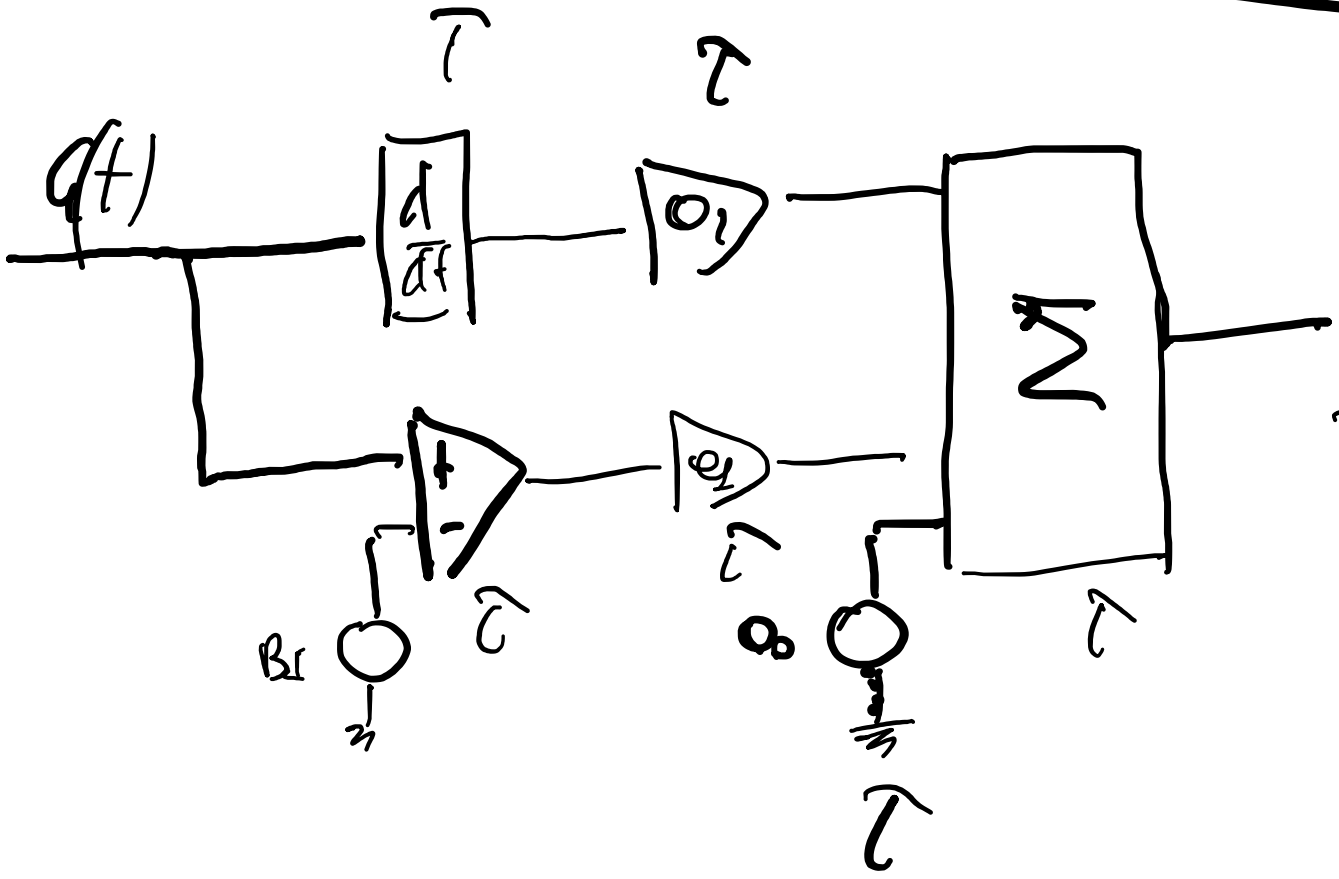


Figura 21: risposta dell'algoritmo di Fisher a uno stimolo

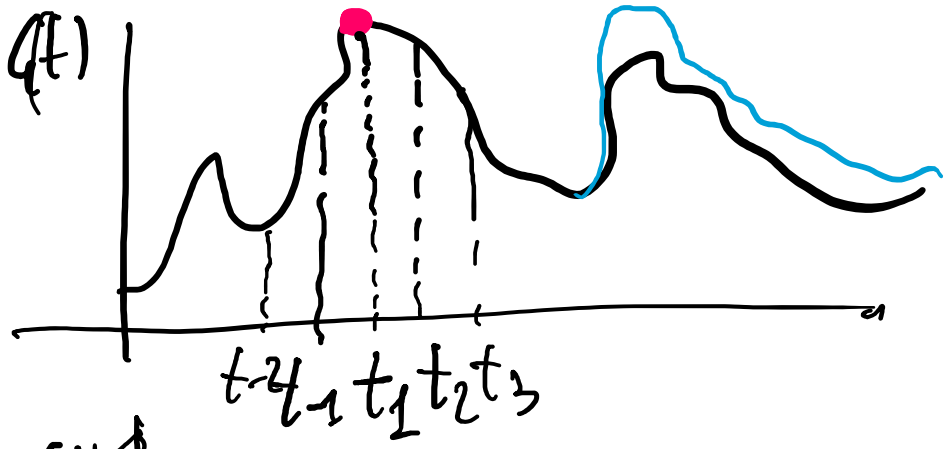
$$I(t) = a_0 + a_1 (q(t) - BI) + a_2 \frac{dq}{dt}$$

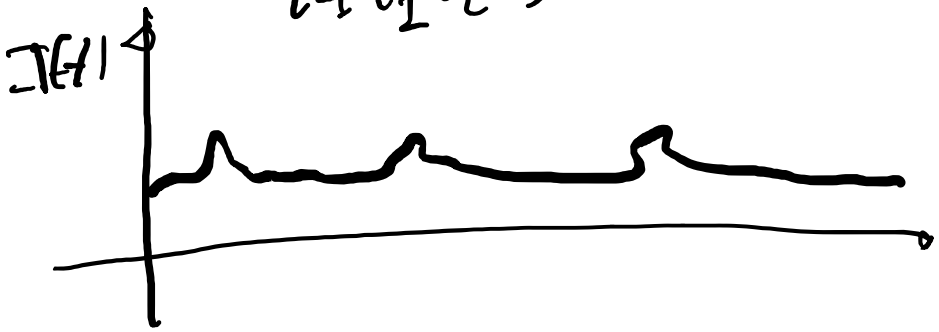


$T_S = 4\tau$

$T_D = \frac{6\tau}{3\tau}$

$a_0, a_1, a_2 > 0$





t_{-1} t_1 t_2 $\tau =$ 15 min

t_1 t_2 t_3

t_{-2} t_{-1} t_2

$$I(t_1) = a_0 + a_1 [C(t_1) - BI]_{+0} \frac{C(t_1) - C(t_{1-1})}{\tau}$$

$$I(t_2) = a_0 + a_1 [C(t_1) - BI]_+ a_2 \frac{C(t_1) - C(t_1)}{\tau}$$

$$I(t_3) = a_0 + a_1 [C(t_3) - BI] + a_2 \frac{C(t_3) - C(t_1)}{\tau}$$

$I(t_1) = 2 + 2 = 4 \frac{\mu g}{ml}$

$I(t_{n1}) = I(t_1) - \frac{1}{4} I(t_1)$

$I(t_3) = I(t_2) - \frac{1}{4} I(t_2)$

Metodi adattivi

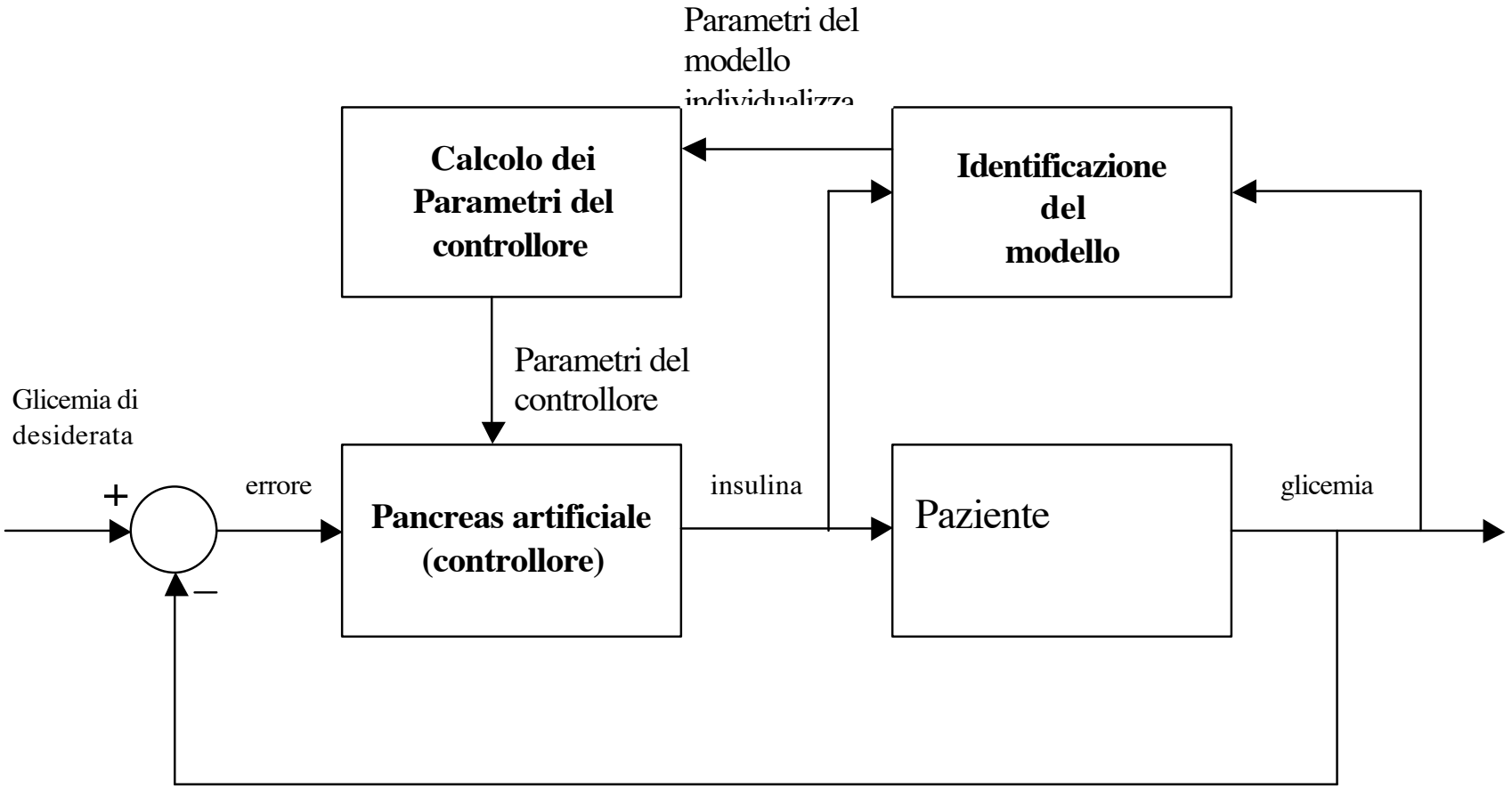


Figura 21:schema di un controllo adattivo self-tuning

Pompa impiantabile di insulina

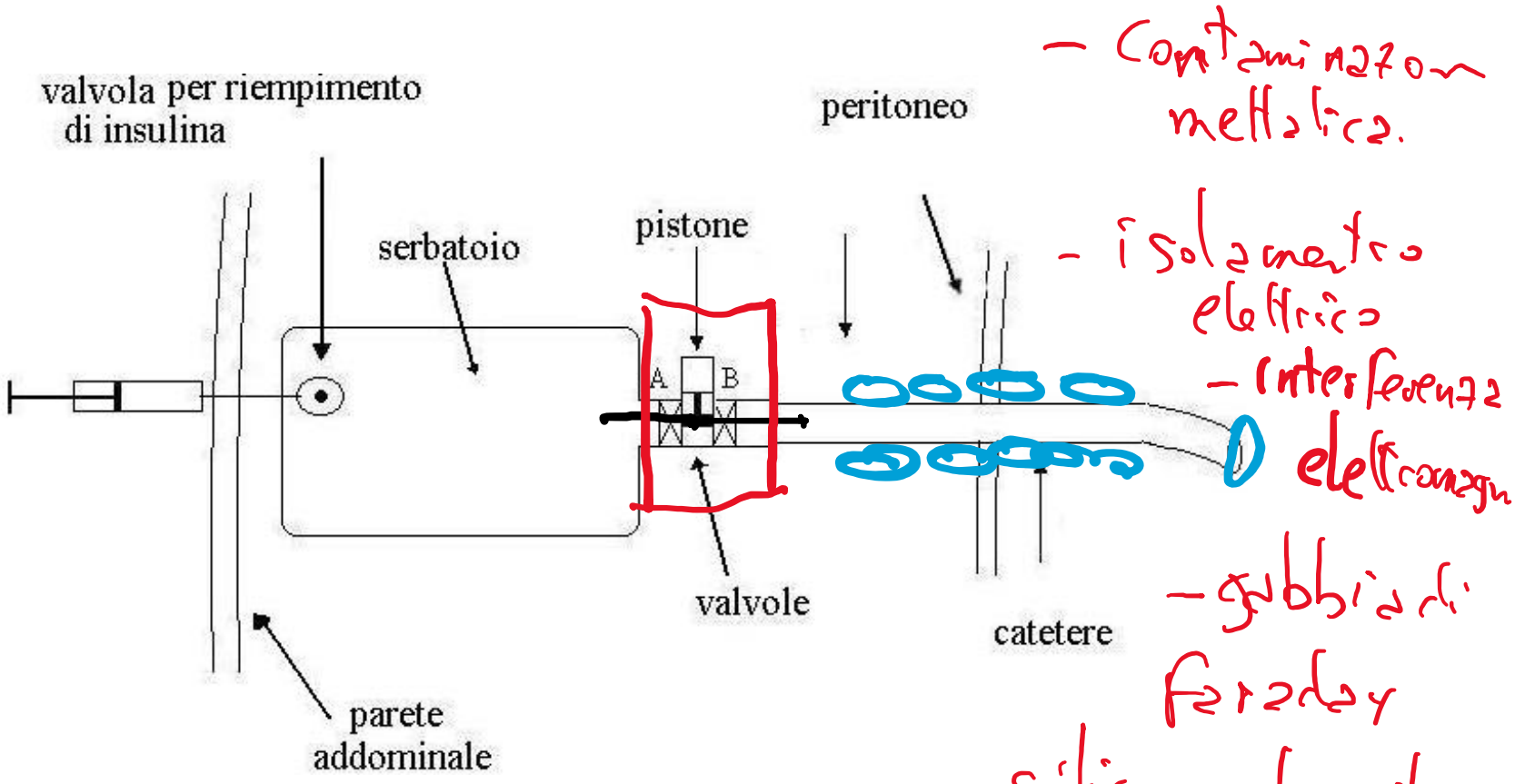


Figura 22: schema di una pompa impiantabile per insulina