

3.3 THE LAC OPERON: COMBINATORIAL GENE REGULATION

OPERON: ONE PROMOTER, ONE (POLYCYSTRONIC) mRNA,
MULTIPLE PROTEINS

LACTOSE: SUGAR (IN MILK)

LAC OPERON: REGULATES LACTOSE UTILIZATION (3 GENES):

lac Z: β -GALACTOSIDASE, cleaves lactose into galactose + glucose

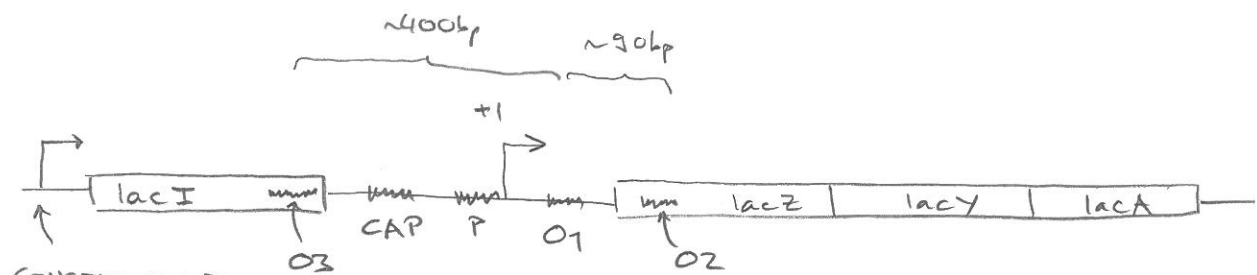
lac Y: PERMEASE; pumps lactose into the cell

lac A: TRANSACETYLASE

When are these genes needed?

- (i) When there is lactose
- (ii) when there is no glucose (better sugar).

STRUCTURE OF LAC OPERON



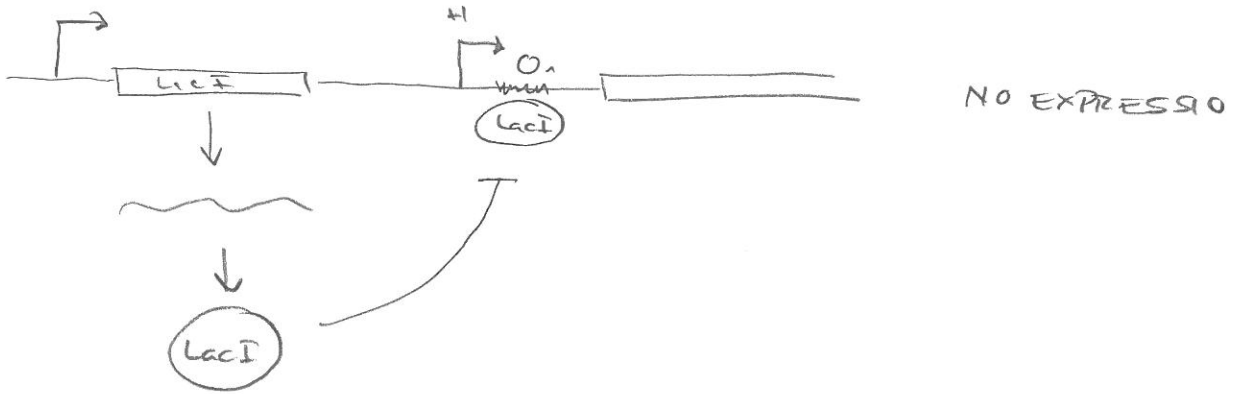
CONSTITUTIVE
PROMOTER
(ALWAYS ON)

lac I: LAC REPRESSOR

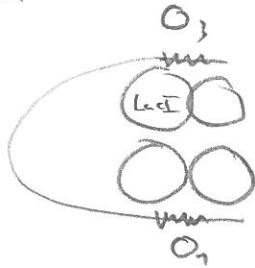
O1, O2, O3: BINDING SITES FOR LacI (O2, O3: WEAK)

CAP: CATABOLITE ACTIVATOR PROTEIN BINDING SITE

(i) NO LACTOSE

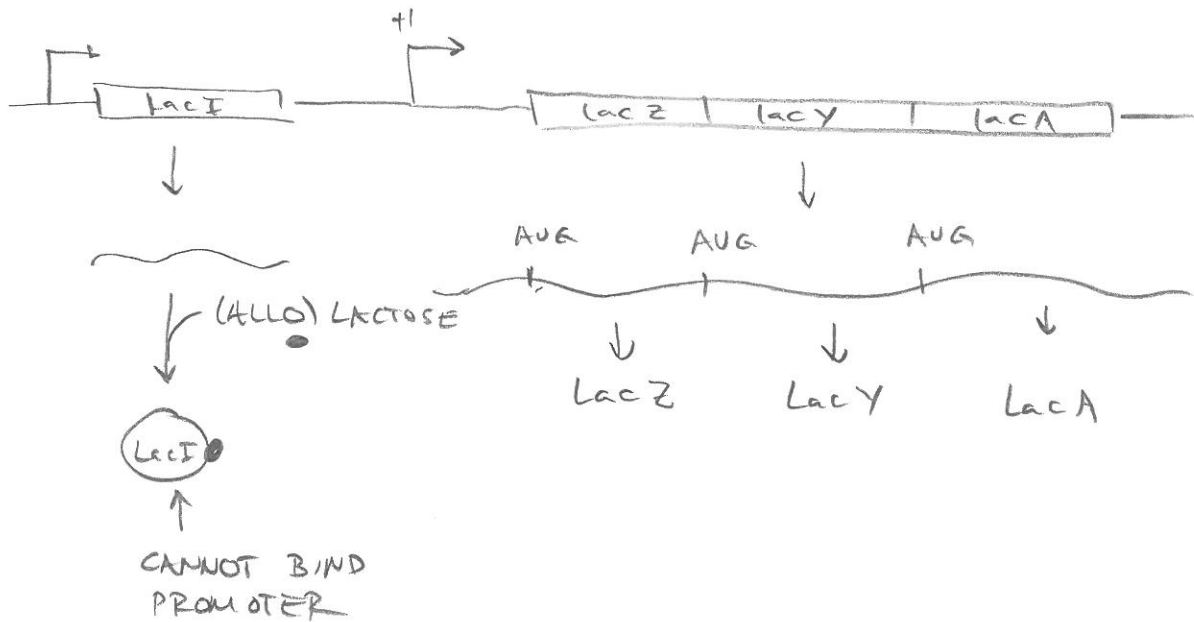


MECHANISM



LacI forms tetramer, binds O_1 and (O_2 or O_3)

(ii) WITH LACTOSE



③

(ii) NO GLUCOSE

CAMP: signaling molecule $[CAMP] \sim 1/[GLUCOSE]$

CAMP HELPS CAP BIND



SUMMARY

LACTOSE	GLUCOSE	OUTPUT	
LOW	LOW	OFF	
HIGH	LOW	ON	
LOW	HIGH	OFF	
HIGH	HIGH	LOW	

MODEL:

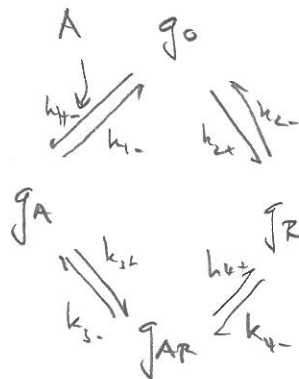
g : Lac Operon, A : CAP, R : LacI

g_0 : No binding

g_A : A bound

g_R : R bound

g_{AR} : A, R bound



$$m = \frac{g_A}{g_{TOT}} \alpha_m - \beta_m m$$

\Rightarrow What is g_A/g_{TOT} ?