

# What Genes Make a Fly's head? Bicoid Plus Hunchback Equal a Buttonhead

Driever and co-workers (1989) predicted that Bicoid must activate other anterior genes besides *hb*. First, deletions of *hb* produced only some of the defects seen in the *bicoid* mutant phenotype. Second, head formation required higher Bicoid concentrations than thorax formation. Bicoid is now known to activate head-forming target genes such as *buttonhead*, *empty spiracles*, and *orthodenticle*, which are expressed in specific subregions of the anterior part of the embryo (Cohen and Jürgens 1990; Finkelstein and Perrimon 1990; Grossniklaus et al. 1994). Driever and co-workers (1989) also predicted that the promoters of such head-specific genes would have low-affinity binding sites for Bicoid protein, causing them to be activated only at extremely high concentrations of Bicoid—that is, near the anterior tip of the embryo. In addition to needing high Bicoid levels for activation, transcription of these genes also requires the presence of Hunchback protein (Simpson-Brose et al. 1994; Reinitz et al. 1995). Bicoid and Hunchback act synergistically at the enhancers of these “head genes” to promote their transcription in a feedforward manner.

In the posterior half of the embryo, the Caudal protein gradient also activates a number of zygotic genes, including the gap genes *knirps* (*kni*) and *giant* (*gt*), which are critical for abdominal development (Rivera-Pomar et al. 1995; Schulz and Tautz 1995). Since a second function of Bicoid protein is to inhibit the translation of *caudal* mRNA, Caudal protein is absent from the anterior portion of the embryo. Thus, the posterior-forming genes are not activated in this region.

## Literature Cited

Cohen, S. M. and G. Jürgens. 1990. Mediation of *Drosophila* head development by gap-like segmentation genes. *Nature* 346: 482–485.

[PubMed Link](#)

Driever, W. and C. Nüsslein-Volhard. 1989. The Bicoid protein is a positive regulator of hunchback transcription in the early *Drosophila* embryo. *Nature* 337: 138–143.

[PubMed Link](#)

Finkelstein, R. and N. Perrimon. 1990. The *orthodenticle* gene is regulated by *bicoid* and *torso* and specifies *Drosophila* head development. *Nature* 346: 485–488.

[PubMed Link](#)

Grossniklaus, U., K. M. Cadigan and W. J. Gehring. 1994. Three maternal coordinate systems cooperate in the patterning of the *Drosophila* head. *Development* 120: 3155–3171.

[PubMed Link](#)

Reinitz, J., E. Mjølness and D. H. Sharp. 1995. Model for cooperative control of positional information in *Drosophila* by *bicoid* and maternal hunchback. *J. Exp. Zool.* 271: 47–56.

[PubMed Link](#)

Rivera-Pomar, R., X. Lu, N. Perrimon, H. Taubert and H. Jäckle. 1995. Activation of posterior gap gene expression in the *Drosophila* blastoderm. *Nature* 376: 253–256.

[PubMed Link](#)

Schulz, C. and D. Tautz. 1995. Zygotic caudal regulation by hunchback and its role in abdominal segment formation of the *Drosophila* embryo. *Development* 121: 1023–1028.

[PubMed Link](#)

Simpson-Brose, M., J. Treisman and C. Desplan. 1994. Synergy between the hunchback and *bicoid* morphogens is required for anterior patterning in *Drosophila*. *Cell* 78: 855–865.

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