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gcm2 Promotes Glial Cell Differentiation and Is Required with *glial cells missing* for Macrophage Development in *Drosophila*

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Abstract

glial cells missing (*gcm*) is the primary regulator of glial cell fate in *Drosophila*. In addition, *gcm* has a role in the differentiation of the plasmatocyte/macrophage lineage of hemocytes. Since mutation of *gcm* causes only a decrease in plasmatocyte numbers without changing their ability to convert into macrophages, *gcm* cannot be the sole determinant of plasmatocyte/macrophage differentiation. We have characterized a *gcm* homolog, *gcm2*. *gcm2* is expressed at low levels in glial cells and hemocyte precursors. We show that *gcm2* has redundant functions with *gcm* and has a minor role promoting glial cell differentiation. More significant, like *gcm*, mutation of *gcm2* leads to reduced plasmatocyte numbers. A deletion removing both genes has allowed us to clarify the role of these redundant genes in plasmatocyte development. Animals deficient for both *gcm* and *gcm2* fail to express the macrophage receptor Croquemort. Plasmatocytes are reduced in number, but still express the early marker Peroxidasin. These Peroxidasin-expressing hemocytes fail to migrate to their normal locations and do not complete their conversion into macrophages. Our results suggest that both *gcm* and *gcm2* are required together for the proliferation of plasmatocyte precursors, the expression of Croquemort protein, and the ability of plasmatocytes to convert into macrophages.

Keywords

glial cells missing; *gcm*; *gcm2*; glia; hemocyte; plasmatocyte; macrophage; blood cells; *Drosophila*

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References

REFERENCES

1 J.M Abrams, K White, L.I Fessler, H Steller
Programmed cell death during Drosophila embryogenesis
Development, 117 (1993), pp. 29-43

2 M.D Adams, S.E Celniker, R.A Holt, C.A Evans, J.D Gocayne, P.G Amanatides, S.E Scherer, P.W Li, R.A Hoskins, R.F Galle
The genome sequence of *Drosophila melanogaster*
Science, 287 (2000), pp. 2185-2195

3 Y Akiyama, T Hosoya, A.M Poole, Y Hotta
The gcm-motif: A novel DNA-binding motif conserved in Drosophila and mammals
Proc. Natl. Acad. Sci. USA, 93 (1996), pp. 14912-14916

4 Y Akiyama-Oda, T Hosoya, Y Hotta
Alteration of cell fate by ectopic expression of Drosophila glial cells missing in non-neural cells
Dev. Genes Evol., 208 (1998), pp. 578-585

5 S.F Altschul, T.L Madden, A.A Schaffer, J Zhang, Z Zhang, W Miller, D.J Lipman
Gapped BLAST and PSI-BLAST: A new generation of protein database search programs
Nucleic Acids Res., 25 (1997), pp. 3389-3402

6 Y Altshuller, N.G Copeland, D.J Gilbert, N.A Jenkins, M.A Frohman
Gcm1, a mammalian homolog of Drosophila glial cells missing
FEBS Lett., 393 (1996), pp. 201-204
Article PDF (421KB)

7 R Bernardoni, A.A Miller, A Giangrande
Glial differentiation does not require a neural ground state
Development, 125 (1998), pp. 3189-3200

8 R Bernardoni, B Vivancos, A Giangrande
glide/gcm is expressed and required in the scavenger cell lineage
Dev. Biol., 191 (1997), pp. 118-130

9 A.H Brand, N Perrimon
Targeted gene expression as a means of altering cell fates and generating dominant phenotypes
Development, 118 (1993), pp. 401-415

10 G Campbell, H Goring, T Lin, E Spana, S Andersson, C.Q Doe, A Tomlinson
RK2, a glial-specific homeodomain protein required for embryonic nerve cord condensation and viability in Drosophila
Development, 120 (1994), pp. 2957-2966

11 J.R Crew, P Batterham, J.A Pollock
Developing compound eye in lozenge mutants of Drosophila: Lozenge expression in the R7 equivalence group
Dev. Genes Evol., 206 (1997), pp. 481-493

12 N Fossett, S.G Tevosian, K Gajewski, Q Zhang, S.H Orkin, R.A Schulz
The Friend of GATA proteins U-shaped, FOG-1, and FOG-2 function as negative regulators of blood, heart, and eye development in Drosophila
Proc. Natl. Acad. Sci. USA, 98 (2001), pp. 7342-7347

13 N.C Franc, J.L Dimarcq, M Lagueux, J Hoffmann, R.A Ezekowitz
Croquemort, a novel Drosophila hemocyte/macrophage receptor that recognizes apoptotic cells
Immunity, 4 (1996), pp. 431-443
Article PDF (508KB)

14 N.C Franc, P Heitzler, R.A Ezekowitz, K White
Requirement for croquemort in phagocytosis of apoptotic cells in Drosophila
Science, 284 (1999), pp. 1991-1994

15 M.R Freeman, C.Q Doe
Asymmetric Prospero localization is required to generate mixed neuronal/glial lineages in the Drosophila CNS
Development, 128 (2001), pp. 4103-4112

16 D.A Halter, J Urban, C Rickert, S.S Ner, K Ito, A.A Travers, G.M Technau
The homeobox gene repo is required for the differentiation and maintenance of glia function in the embryonic nervous system of *Drosophila melanogaster*
Development, 121 (1995), pp. 317-332

17 T Hosoya, K Takizawa, K Nitta, Y Hotta
glial cells missing: A binary switch between neuronal and glial determination in Drosophila
Cell, 82 (1995), pp. 1025-1036

Article PDF (11MB)

18 B.W Jones, R.D Fetter, G Tear, C.S Goodman
glial cells missing: A genetic switch that controls glial versus neuronal fate
Cell, 82 (1995), pp. 1013-1023
Article PDF (13MB)

19 M Kammerer, A Giangrande
Glide2, a second glial promoting factor in Drosophila melanogaster
EMBO J., 20 (2001), pp. 4664-4673

20 J Kim, B.W Jones, C Zock, Z Chen, H Wang, C.S Goodman, D.J Anderson
Isolation and characterization of mammalian homologs of the Drosophila gene glial cells missing
Proc. Natl. Acad. Sci. USA, 95 (1998), pp. 12364-12369

21 A Klaes, T Menne, A Stollewerk, H Scholz, C Klambt
The Ets transcription factors encoded by the Drosophila gene pointed direct glial cell differentiation in the embryonic CNS
Cell, 78 (1994), pp. 149-160
Article PDF (13MB)

22 M.E Lane, D Kalderon
Genetic investigation of cAMP-dependent protein kinase function in Drosophila development
Genes Dev., 7 (1993), pp. 1229-1243

23 T Lebestky, T Chang, V Hartenstein, U Banerjee
Specification of Drosophila hematopoietic lineage by conserved transcription factors
Science, 288 (2000), pp. 146-149

24 G.C Liao, E.J Rehm, G.M Rubin
Insertion site preferences of the P transposable element in *Drosophila melanogaster*
Proc. Natl. Acad. Sci. USA, 97 (2000), pp. 3347-3351

25 B Mathey-Prevot, N Perrimon
Mammalian and Drosophila blood: JAK of all trades?
Cell, 92 (1998), pp. 697-700
Article PDF (69KB)

26 R.E Nelson, L.I Fessler, Y Takagi, B Blumberg, D.R Keene, P.F Olson, C.G Parker, J.H Fessler
Peroxidasin: A novel enzyme-matrix protein of Drosophila development
EMBO J., 13 (1994), pp. 3438-3447

27 N.H Patel
Imaging neuronal subsets and other cell types in whole-mount Drosophila embryos and larvae using antibody probes
Methods Cell Biol., 44 (1994), pp. 445-487
Article PDF (3MB)

28 K.P Rehorn, H Thelen, A.M Michelson, R Reuter
A molecular aspect of hematopoiesis and endoderm development common to vertebrates and Drosophila
Development, 122 (1996), pp. 4023-4031

29 R Reifegerste, J Schreiber, S Gulland, A Ludemann, M Wegner
mGCMa is a murine transcription factor that overrides cell fate decisions in Drosophila
Mech. Dev., 82 (1999), pp. 141-150
Article PDF (689KB)

30 P Rorth, K Szabo, A Bailey, T Laverty, J Rehm, G.M Rubin, K Weigmann, M Milan, V Benes, W Ansorge, S.M Cohen
Systematic gain-of-function genetics in Drosophila
Development, 125 (1998), pp. 1049-1057

31 G.M Rubin, L Hong, P Brokstein, M Evans-Holm, E Frise, M Stapleton, D.A Harvey
A Drosophila complementary DNA resource
Science, 287 (2000), pp. 2222-2224

32 H Schmidt, C Rickert, T Bossing, O Vef, J Urban, G.M Technau
The embryonic central nervous system lineages of *Drosophila melanogaster*. II. Neuroblast lineages derived from the dorsal part of the neuroectoderm
Dev. Biol., 189 (1997), pp. 186-204
Article PDF (3MB)

33 J Schreiber, J Enderich, M Wegner
Structural requirements for DNA binding of GCM proteins
Nucleic Acids Res., 26 (1998), pp. 2337-2343

34 J Schreiber, E Sock, M Wegner
The regulator of early gliogenesis glial cells missing is a transcription factor with a novel type of DNA-binding domain
Proc. Natl. Acad. Sci. USA, 94 (1997), pp. 4739-4744

35 U Tepass, L.I Fessler, A Aziz, V Hartenstein
Embryonic origin of hemocytes and their relationship to cell death in Drosophila
Development, 120 (1994), pp. 1829-1837

36 E.E Tuerk, J Schreiber, M Wegner
Protein stability and domain topology determine the transcriptional activity of the mammalian glial cells missing homolog, GCMb
J. Biol. Chem., 275 (2000), pp. 4774-4782

37 S Vincent, J.L Vonesch, A Giangrande
Glide directs glial fate commitment and cell fate switch between neurones and glia
Development, 122 (1996), pp. 131-139

38 A Wodarz, U Hinz, M Engelbert, E Knust
Expression of crumbs confers apical character on plasma membrane domains of ectodermal epithelia of Drosophila
Cell, 82 (1995), pp. 67-76
Article PDF (4MB)

39 W.C Xiong, H Okano, N.H Patel, J.A Blendy, C Montell
repo encodes a glial-specific homeo domain protein required in the Drosophila nervous system
Genes Dev., 8 (1994), pp. 981-994

40 K Zinn, L McAllister, C.S Goodman
Sequence analysis and neuronal expression of fasciclin I in grasshopper and Drosophila
Cell, 53 (1988), pp. 577-587
Article PDF (4MB)

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