

In parallel, plasmid pYES-CK2 β 1 was used to transform strain YDH8 (MATa *cka1-Δ1::HIS3 cka2-Δ1::TRP1*), which contains a centromeric plasmid carrying the *cka2-8* allele. The presence of the *cka2-8* allele allows growth at 30°C, although it results in cell-cycle arrest upon shift to 37°C. Positive clones were selected in Ura- plates. Transformants were plated in YPD and YPGal plates, and incubated at 30 or 37°C.

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References

- Allende, J.E. and Allende, C.C. (1995) Protein kinase CK2: an enzyme with multiple substrates and a puzzling regulation. *FASEB J.* **9**, 313–323.
- Altschul, S.F., Gish, W., Miller, W., Myers, E.W. and Lipman, D.J. (1990) Basic local alignment search tool. *J. Mol. Biol.* **215**, 403–410.
- Battistutta, R., Sarno, S., De Moliner, E., Marin, O., Issinger, O.G., Zanotti, G. and Pinna, L.A. (2000) The crystal structure of the complex of *Zea mays* alpha subunit with a fragment of human beta subunit provides the clue to the architecture of protein kinase CK2 holoenzyme. *Eur J. Biochem.* **267**, 5184–5190.
- Bidwai, A.P., Hanna, D.E. and Glover, C.V.C. (1992) Purification and characterization of casein kinase II (CKII) from delta cka1 delta cka2 *Saccharomyces cerevisiae* rescued by *Drosophila* CKII subunits. *J. Biol. Chem.* **267**, 18790–18796.
- Bidwai, A.P., Reed, J.C. and Glover, C.V.C. (1993) Phosphorylation of calmodulin by the catalytic subunit of casein kinase II is inhibited by the regulatory subunit. *Arch. Biochem. Biophys.* **300**, 265–270.
- Bidwai, A.P., Reed, J.C. and Glover, C.V.C. (1994) Casein kinase II of *Saccharomyces cerevisiae* contains two distinct regulatory subunits, b and b'. *Arch. Biochem. Biophys.* **309**, 348–355.
- Bidwai, A.P., Reed, J.C. and Glover, C.V.C. (1995) Cloning and disruption of CKB1, the gene encoding the 38 kDa beta subunit of *Saccharomyces cerevisiae* casein kinase II (CKII). *J. Biol. Chem.* **270**, 10395–10404.
- Bidwai, A.P., Zhao, W. and Glover, C.V.C. (1999) A gene located at 56F1-2 in *Drosophila melanogaster* encodes a novel metazoan beta-like subunit of casein kinase II. *Mol. Cell. Biol. Res. Commun.* **1**, 21–28.
- Boldyreff, B., Meggio, F., Dobrowolska, G., Pinna, L.A. and Issinger, O.-G. (1993) Expression and characterization of a recombinant maize CK-2 α subunit. *Biochim. Biophys. Acta*, **1173**, 32–38.
- Busk, P.K. and Pagès, M. (1997) Protein binding to the abscisic acid-responsive element is independent of VIVIPAROUS 1 *in vivo*. *Plant Cell*, **9**, 2261–2270.
- Chantalat, L., Leroy, D., Filhol, O., Nueda, A., Benítez, M.J., Chambaz, E.M., Cochet, C. and Didierberg, O. (1999) Crystal structure of the human protein kinase CK2 regulatory subunit reveals its zinc finger-mediated dimerization. *EMBO J.* **18**, 2930–2940.
- Chen, K., Li, D., Krebs, E.G. and Cooper, J.A. (1997) The casein kinase II beta subunit binds to Mos and inhibits Mos activity. *Mol. Cell. Biol.* **4**, 1904–1912.
- Collinge, M.A. and Walker, J.C. (1994) Isolation of an *Arabidopsis thaliana* casein kinase II β subunit by complementation in *Saccharomyces cerevisiae*. *Plant Mol. Biol.* **25**, 649–658.
- de Nadal, E., Calero, F., Ramos, J. and Ariño, J. (1999) Biochemical and genetic analyses of the role of yeast casein kinase 2 in salt tolerance. *J. Bacteriol.* **181**, 6456–6462.
- Dobrowolska, G., Boldyreff, B. and Issinger, O.-G. (1991) Cloning and sequencing of the casein kinase 2 α subunit from *Zea mays*. *Biochem. Biophys. Acta*, **1129**, 139–140.
- Dobrowolska, G., Meggio, F., Szczegielniak, J., Muszynska, G. and Pinna, L.A. (1992) Purification and characterization of maize seedling casein kinase IIB, a monomeric enzyme immunologically related to the α subunit of animal casein kinase-2. *Eur. J. Biochem.* **204**, 299–303.
- Espunya, M.C., Combettes, B., Dot, J., Chaubet-Gigot, N. and Martínez, M.C. (1999) Cell-cycle modulation of CK2 activity in tobacco BY-2 cells. *Plant J.* **19**, 655–666.
- Fields, S. and Song, O. (1989) A novel genetic system to detect protein–protein interactions. *Nature*, **340**, 245–246.
- Frangioni, J.V. and Neel, B.G. (1993) Solubilization and purification of enzymatically active glutathione S-transferase (pGEX) fusion proteins. *Anal. Biochem.* **210**, 179–187.
- Gietz, R.D., Graham, K.C. and Litchfield, D.W. (1995) Interactions between the subunits of casein kinase II. *J. Biol. Chem.* **270**, 13017–13021.
- Goday, A., Jensen, A.B., Culiañez-Macià, F.B., Albà, M.M., Figueras, M., Serratosa, J., Torrent, M. and Pagès, M. (1994) The maize abscisic acid-responsive protein rab17 is located in the nucleus and interacts with nuclear localization signals. *Plant Cell*, **6**, 351–360.
- Gómez, J., Sanchez-Martinez, D., Steifel, V., Rigau, J., Puigdomenech, P. and Pagès, M. (1988) A gene induced by the plant hormone abscisic acid in response to water stress encodes a glycine-rich protein. *Nature*, **334**, 262–264.
- Grankowski, N., Boldyreff, B. and Issinger, O.G. (1991) Isolation and characterization of recombinant human casein kinase II subunits α and β from bacteria. *Eur. J. Biochem.* **198**, 25–30.
- Guerra, B. and Issinger, O.-G. (1999) Protein kinase CK2 and its role in cellular proliferation, development and pathology. *Electrophoresis*, **20**, 391–406.
- Guerra, B., Boldyreff, B., Sarno, S., Cesaro, L., Issinger, O.G. and Pinna, L.A. (1999) CK2: a protein kinase in need of control. *Pharmacol. Ther.* **82**, 303–313.
- Hanna, D.E., Rethinaswamy, A. and Glover, C.V.C. (1995) Casein kinase II is required for cell cycle progression during G1 and G2/M in *Saccharomyces cerevisiae*. *J. Biol. Chem.* **270**, 25905–25914.
- Hu, E. and Rubin, C.S. (1990) Casein kinase II from *Caenorhabditis elegans*: cloning characterization and developmental regulation of the gene encoding the β subunit. *J. Biol. Chem.* **266**, 19796–19802.
- Klimczak, L.J., Schindler, U. and Cashmore, A.R. (1992) DNA-binding activity of the *Arabidopsis* G-box binding factor GBF1 is stimulated by phosphorylation by casein kinase II from broccoli. *Plant Cell*, **4**, 87–98.
- Krehan, A., Lorenz, P., Plana-Coll, M. and Pyerin, W. (1996) Interaction sites between catalytic and regulatory subunits in human protein kinase CK2 holoenzymes as indicated by chemical cross-linking and immunological investigations. *Biochemistry*, **35**, 4966–4975.
- Lee, Y., Lloyd, A.M. and Roux, S.J. (1999) Antisense expression of