

larizing to at least +90 mV for at least 2 min. (2) 16HBE cells were exposed to trypsin for 2–3 min followed by incubation in low Ca²⁺ bath solution at 37 °C for 18 h before patching. This treatment was milder than that used for Calu-3 cells, but cell loss was nevertheless much greater in the 16HBE cells: ~75% of cells detached from the dish, and all remaining cells were isolated and rounded. Patches were excised and held at –50 mV for ~30 sec, and then depolarized as follows: to +50 mV for 30 s, to +100 mV for 100 s and to +150 mV for a further 100 s. Depolarization was stopped if ORDICS were activated.

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- Riordan, J.R. *et al.* Identification of the cystic fibrosis gene: Cloning and characterization of complementary DNA [erratum appears in *Science* **245**, 1437; 1989]. *Science* **245**, 1066–1073 (1989).
- Anderson, M.P. *et al.* Demonstration that CFTR is a chloride channel by alteration of its anion selectivity. *Science* **253**, 202–205 (1991).
- Bear, C.E. *et al.* Purification and functional reconstitution of the cystic fibrosis transmembrane conductance regulator (CFTR). *Cell* **68**, 809–818 (1992).
- Welsh, M.J. An apical-membrane chloride channel in human tracheal epithelium. *Science* **232**, 1648–1650 (1986).
- Egan, M. *et al.* Defective regulation of outwardly rectifying Cl⁻ channels by protein kinase A corrected by insertion of CFTR. *Nature* **358**, 581–584 (1992).
- Schwiebert, E.M. *et al.* CFTR regulates outwardly rectifying chloride channels through an autocrine mechanism involving ATP. *Cell* **81**, 1063–1073 (1995).
- Tabcharani, J.A. & Hanrahan, J.W. On the activation of outwardly rectifying anion channels in excised patches. *Am. J. Physiol.* **261**, G992–G999 (1991).
- Finkbeiner, W.E., Carrier, S.D. & Teresi, C.E. Reverse transcription-polymerase chain reaction (RT-PCR) phenotypic analysis of cell cultures of human tracheal epithelium, tracheobronchial glands, and lung carcinomas. *Am. J. Respir. Cell Mol. Biol.* **9**, 547–556 (1993).
- Shen, B.Q. *et al.* Calu-3: A human airway epithelial cell line that shows cAMP-dependent Cl⁻ secretion. *Am. J. Physiol.* **266**, L493–L501 (1994).
- Haws, C., Finkbeiner, W.E., Widdicombe, J.H. & Wine, J.J. CFTR in Calu-3 human airway cells: Channel properties and role in cAMP-activated Cl⁻ conductance. *Am. J. Physiol.* **266**, L502–L512 (1994).
- Cozens, A.L. *et al.* CFTR expression and chloride secretion in polarized immortal human bronchial epithelial cells. *Am. J. Respir. Cell Mol. Biol.* **10**, 38–47 (1994).
- Haws, C. *et al.* CFTR channels in immortalized human airway cells. *Am. J. Physiol.* **263**, L692–L707 (1992).
- Armitage, W.J., Juss, B.K. & Easty, D.L. Response of epithelial (MDCK) cell junctions

to calcium removal and osmotic stress is influenced by temperature. *Cryobiology* **31**, 453–460 (1994).

- Gray, M.A. *et al.* Two types of chloride channel on duct cells cultured from human fetal pancreas. *Am. J. Physiol.* **257**, C240–C251 (1989).
- Volberg, T., Geiger, B., Kartenbeck, J. & Franke, W.W. Changes in membrane-microfilament interaction in intercellular adherens junctions upon removal of extracellular Ca²⁺ ions. *J. Cell Biol.* **102**, 1832–1842 (1986).
- Shoemaker, R.L., Frizzell, R.A., Dwyer, T.M. & Farley, J.M. Single chloride channel currents from canine tracheal epithelial cells. *Biochim. Biophys. Acta* **858**, 235–242 (1986).
- Gabriel, S.E., Clarke, L.L., Boucher, R.C. & Stutts, M.J. CFTR and outwardly rectifying chloride channels are distinct proteins with a regulatory relationship. *Nature* **363**, 263–268 (1993).
- Schwiebert, E.M., Flotte, T., Cutting, G.R. & Guggino, W.B. Both CFTR and outwardly rectifying chloride channels contribute to cAMP-stimulated whole cell chloride currents. *Am. J. Physiol.* **266**, C1464–C1477 (1994).
- Bridges, R.J., Worrell, R.T., Frizzell, R.A. & Benos, D.J. Stilbene disulfonate blockade of colonic secretory Cl⁻ channels in planar lipid bilayers. *Am. J. Physiol.* **256**, C902–C912 (1989).
- Shen, B.Q., Msrny, R.J., Finkbeiner, W.E. & Widdicombe, J.H. Role of CFTR in chloride secretion across human tracheal epithelium. *Am. J. Physiol.* **269**, L561–L566 (1995).
- Brayden, D.J., Krouse, M.E., Law, T. & Wine, J.J. Stilbenes stimulate T84 Cl⁻ secretion by elevating Ca²⁺. *Am. J. Physiol.* **264**, G325–G333 (1993).
- Bijman, J. *et al.* Characterization of human sweat duct chloride conductance by chloride channel blockers. *Pfluegers Arch.* **408**, 511–514 (1987).
- Grub, B.R., Paradise, A.M. & Boucher, R.C. Anomalies in ion transport in CF mouse tracheal epithelium. *Am. J. Physiol.* **267**, C293–C300 (1994).
- Knolls, M.R., Clarke, L.L. & Boucher, R.C. Activation by extracellular nucleotides of chloride secretion in the airway epithelia of patients with cystic fibrosis. *N. Engl. J. Med.* **325**, 533–538 (1991).
- Stutts, M.J. *et al.* Regulation of Cl⁻ channels in normal and cystic fibrosis airway epithelial cells by extracellular ATP. *Proc. Natl. Acad. Sci. USA* **89**, 1621–1625 (1992).
- Stutts, M.J., Fitz, J.G., Paradise, A.M. & Boucher, R.C. Multiple modes of regulation of airway epithelial chloride secretion by extracellular ATP. *Am. J. Physiol.* **267**, C1442–C1451 (1994).
- Anderson, M.P. & Welsh, M.J. Calcium and cAMP activate different chloride channels in the apical membrane of normal and cystic fibrosis epithelia. *Proc. Natl. Acad. Sci. USA* **88**, 6003–6007 (1991).
- Morris, A.P., Cunningham, S.A., Benos, D.J. & Frizzell, R.A. Cellular differentiation is required for cAMP but not Ca²⁺-dependent Cl⁻ secretion in colonic epithelial cells expressing high levels of cystic fibrosis transmembrane conductance regulator. *J. Biol. Chem.* **267**, 5575–5583 (1992).
- Anderson, M.P., Sheppard, D.N., Berger, H.A. & Welsh, M.J. Chloride channels in the apical membrane of normal and cystic fibrosis airway and intestinal epithelia. *Am. J. Physiol.* **263**, L1–L14 (1992).
- Pisam, M. & Ripoche, P. Redistribution of surface macromolecules in dissociated epithelial cells. *J. Cell Biol.* **71**, 907–920 (1976).
- Graham, A., Steel, D.M., Alton, E.W. & Geddes, D.M. Second-messenger regulation of sodium transport in mammalian airway epithelia. *J. Physiol. (Lond.)* **453**, 475–491 (1992).
- Cammack, J.N. & Schwartz, E.A. Channel behavior in a gamma-aminobutyrate transporter. *Proc. Natl. Acad. Sci. USA* **93**, 723–727 (1996).

ERRATUM

Retinoic acid treatment abrogates elastase-induced pulmonary emphysema in rats

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In the above article, panel *b* of Fig. 1 was incorrectly labeled. The corrected figure appears below. We regret the error.

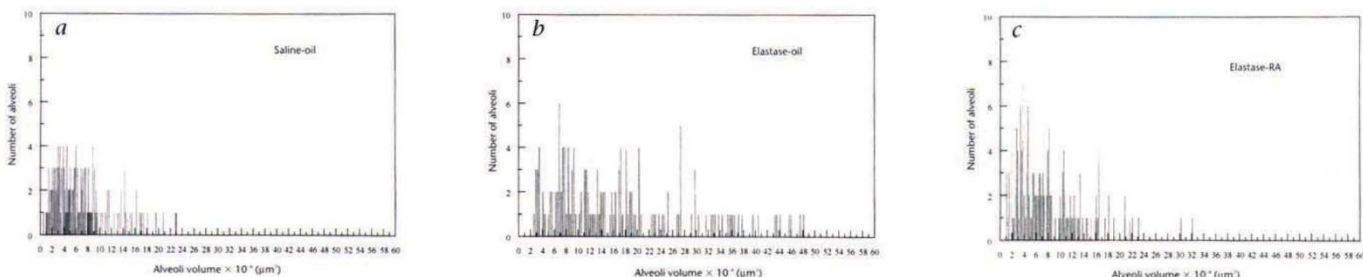


Fig. 1 Treatment with retinoic acid caused a marked reduction in the number of large alveoli in rats previously treated with elastase. Frequency distribution of the volume of individual alveoli in rats treated with *a*, saline-oil; *b*, elastase-oil; and *c*, elastase-retinoic acid.