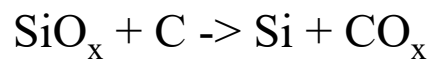
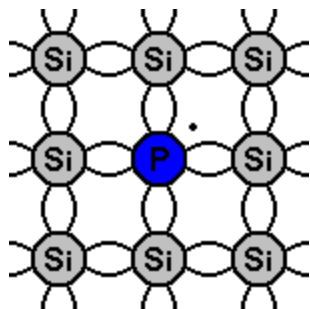
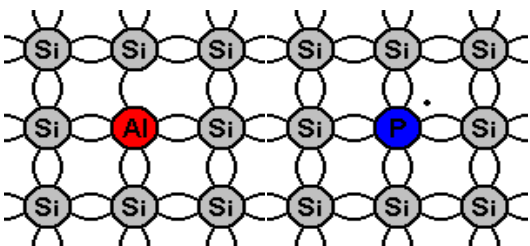
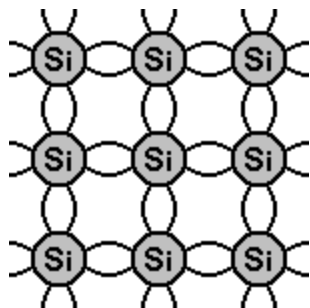


silica sand

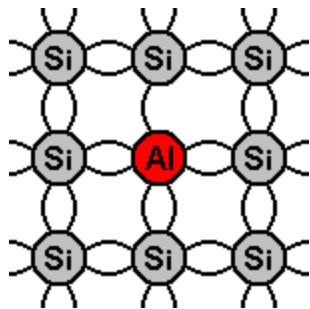
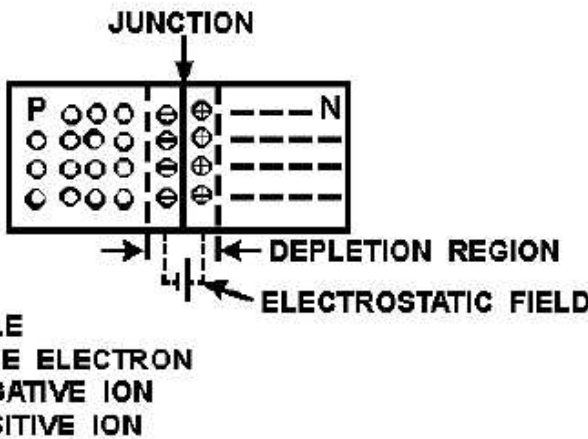
purify and regrow



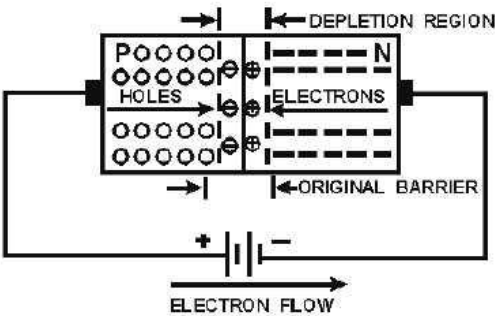
Silicon crystals – doping and conduction



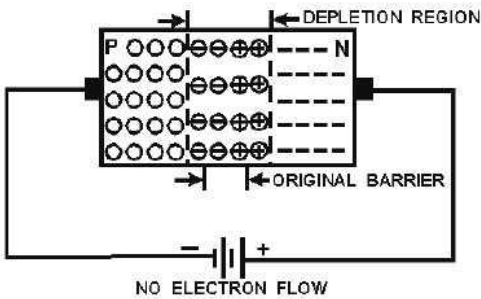
n-type (excess electrons)



p-type (excess holes)

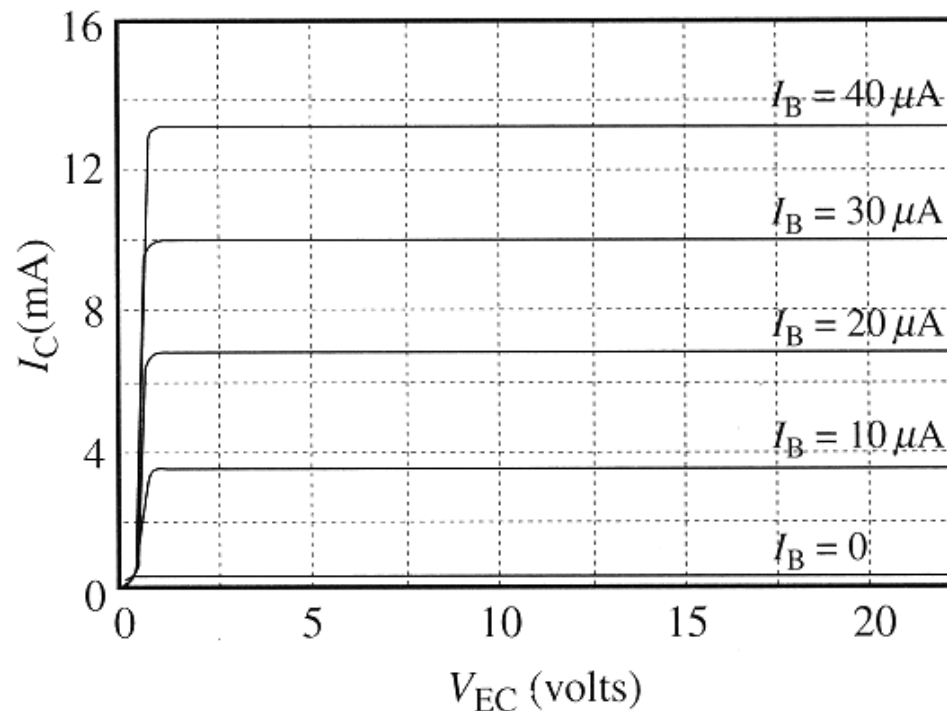
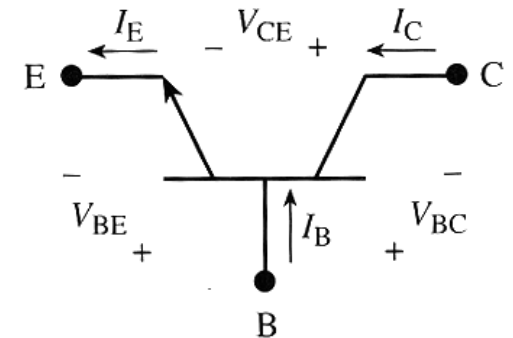
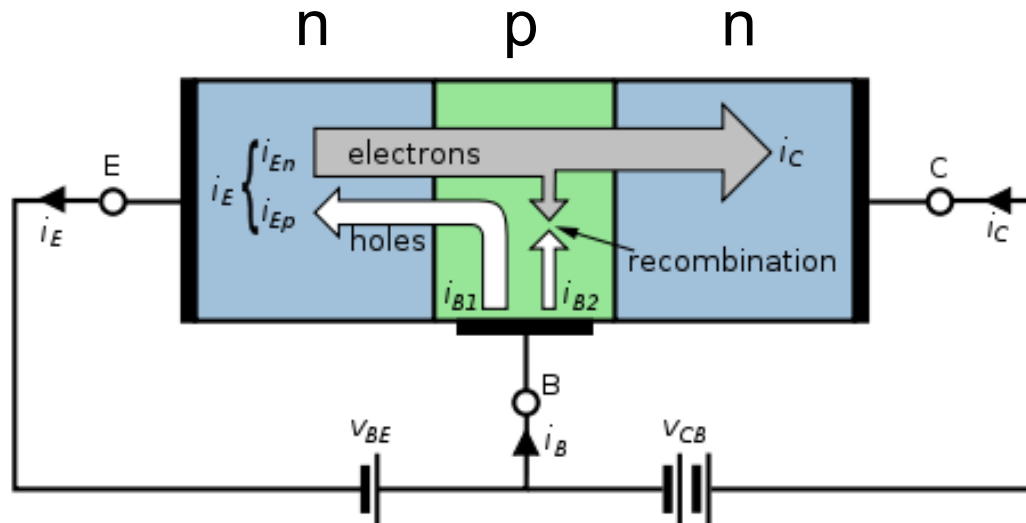


forward bias

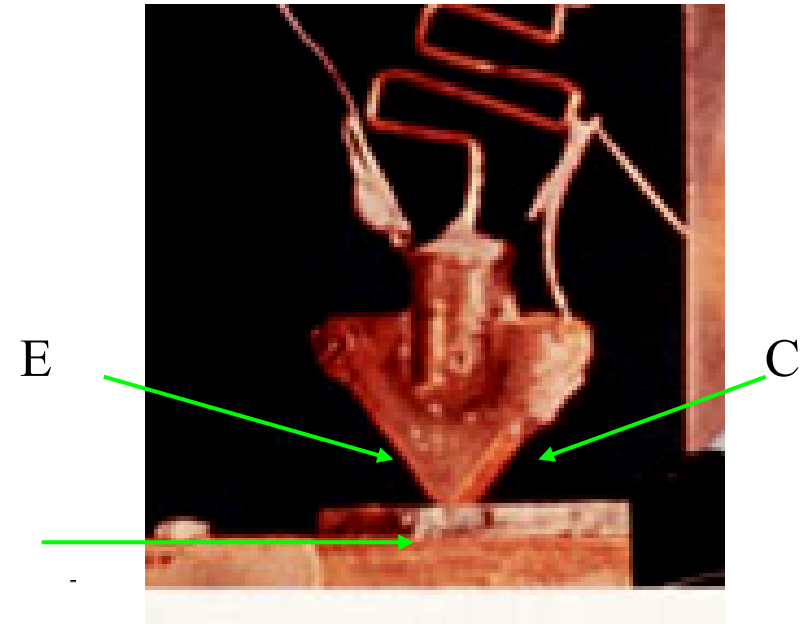
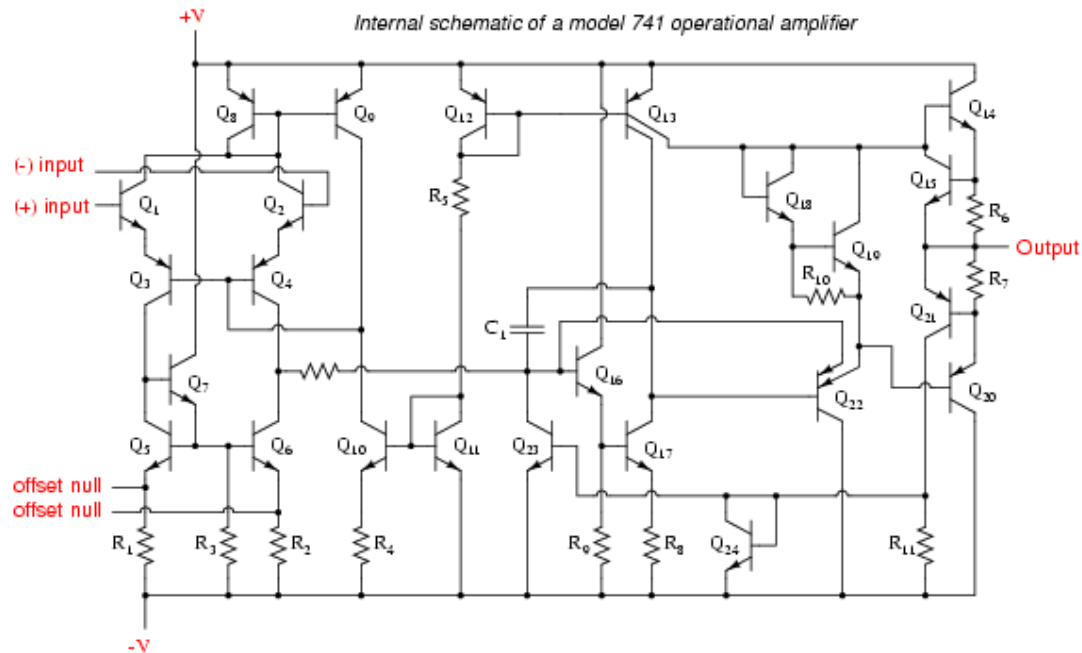
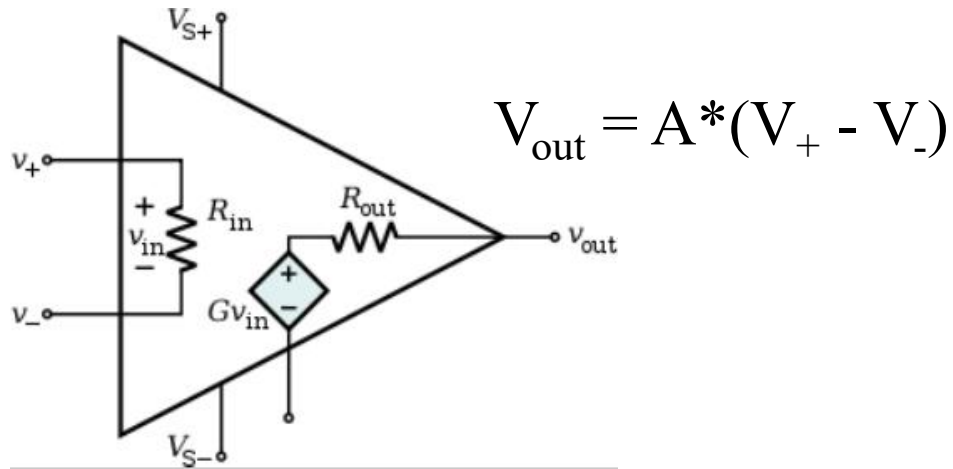


reverse bias

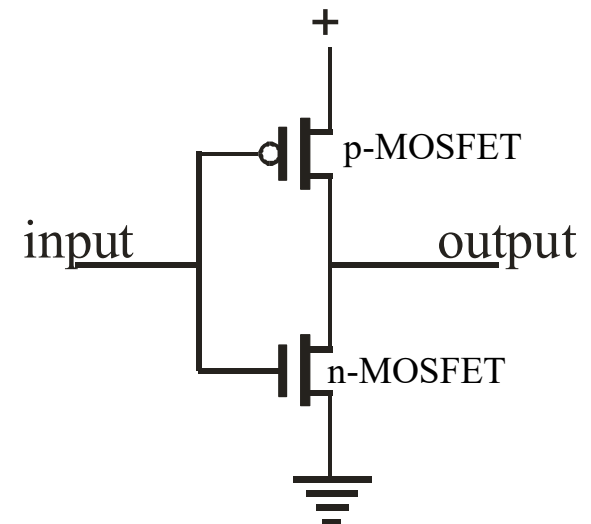
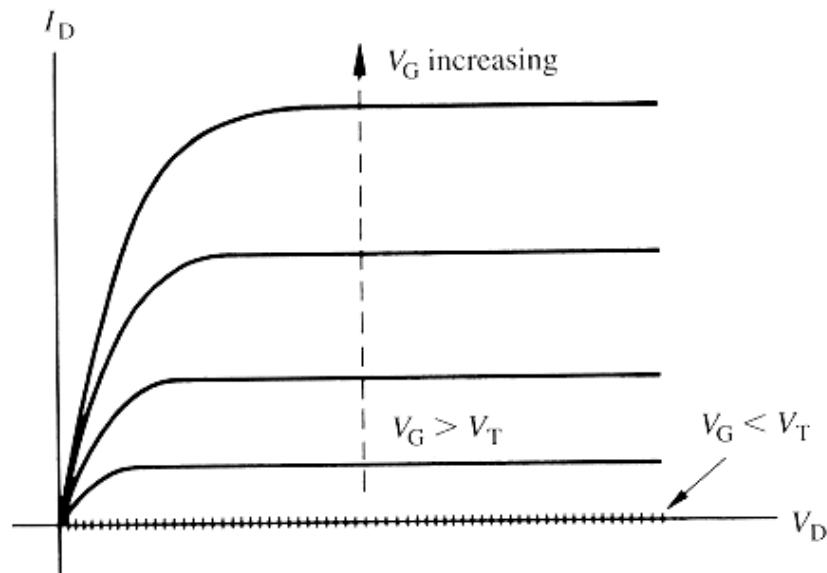
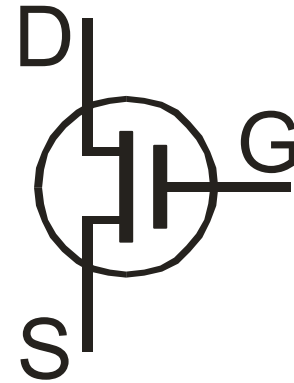
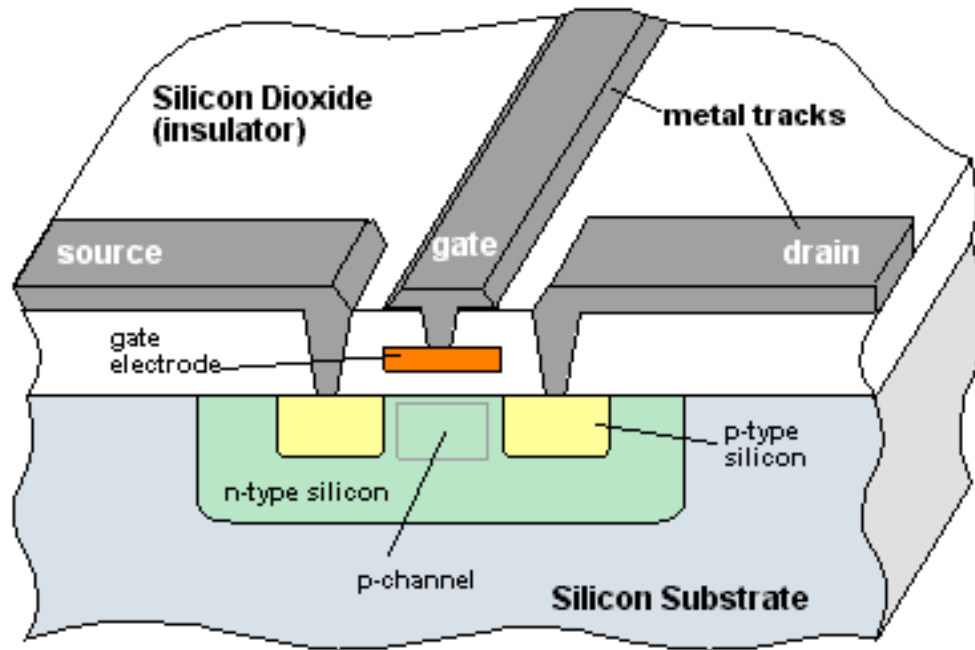
bipolar junction transistor

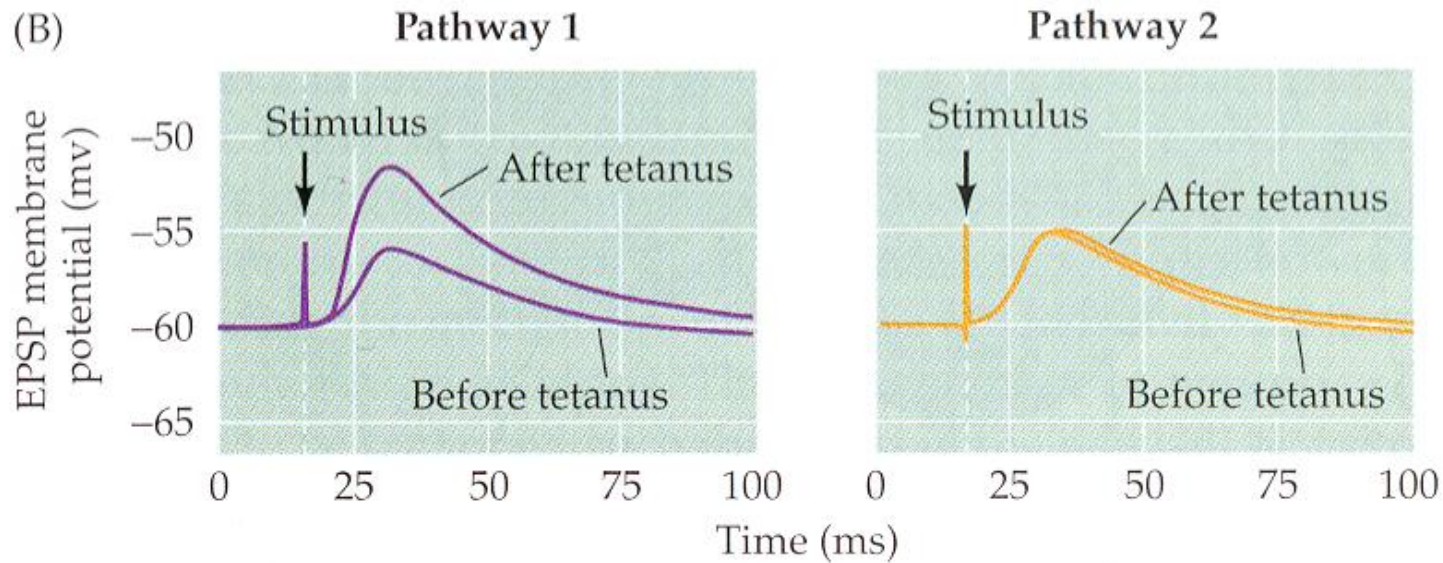
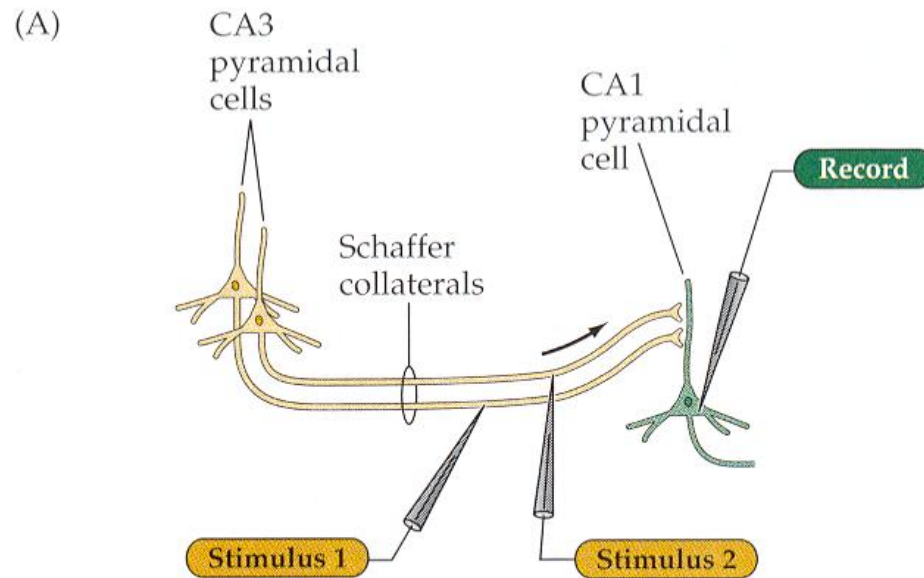


Integration



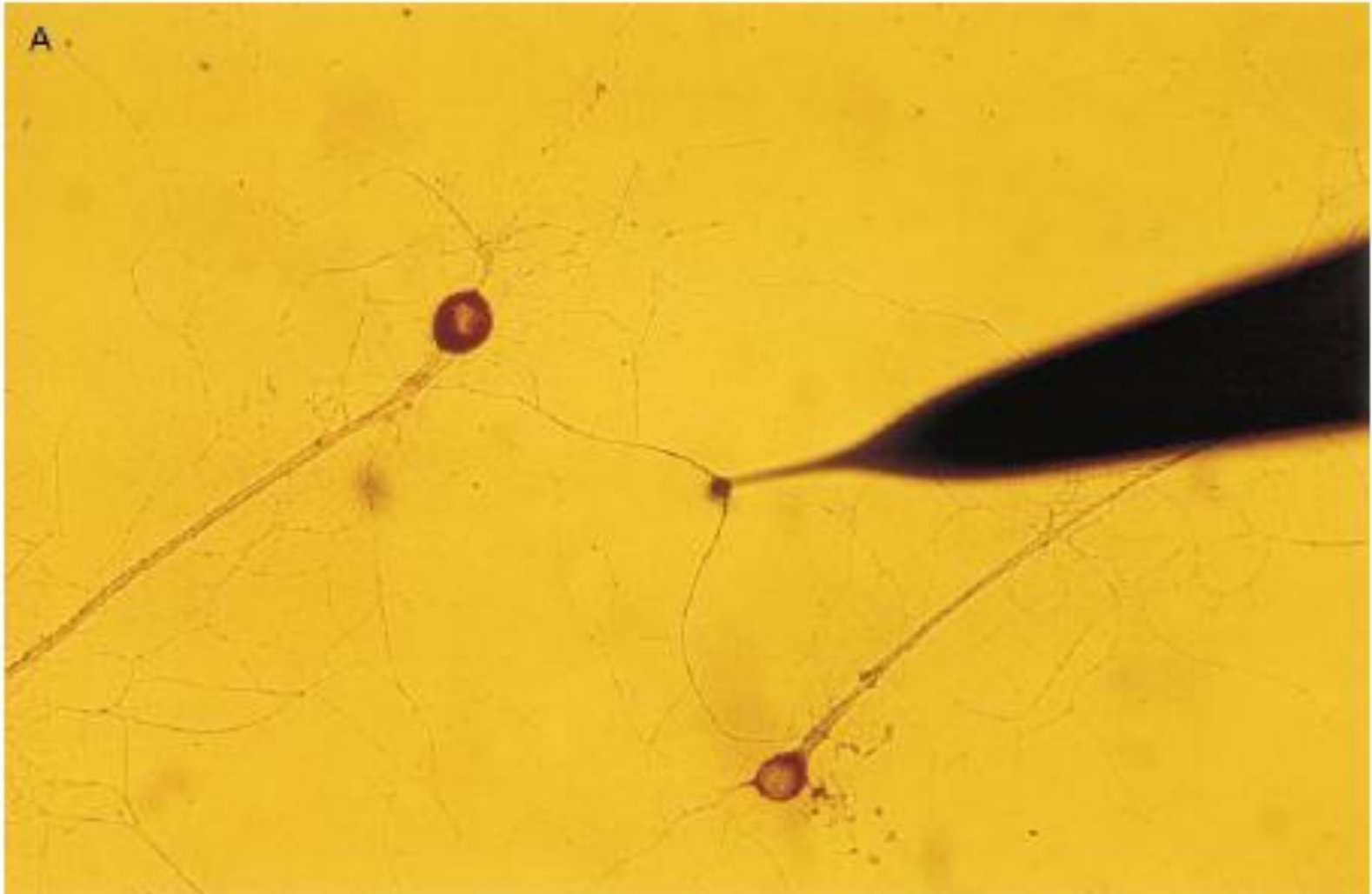
MOSFETs – basic building block of modern electronics

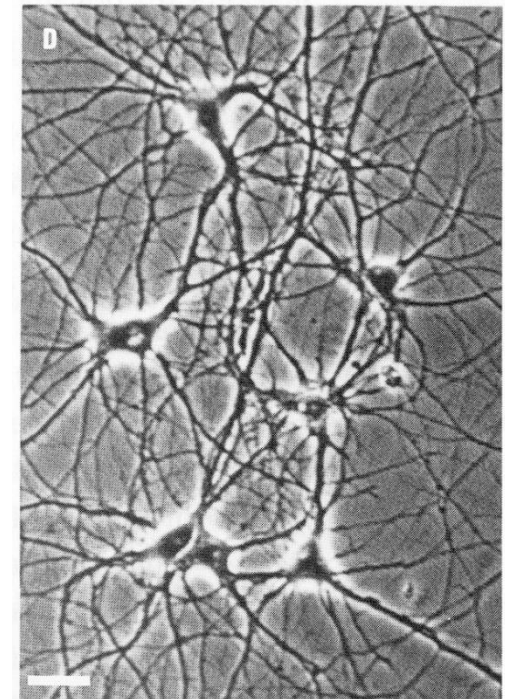
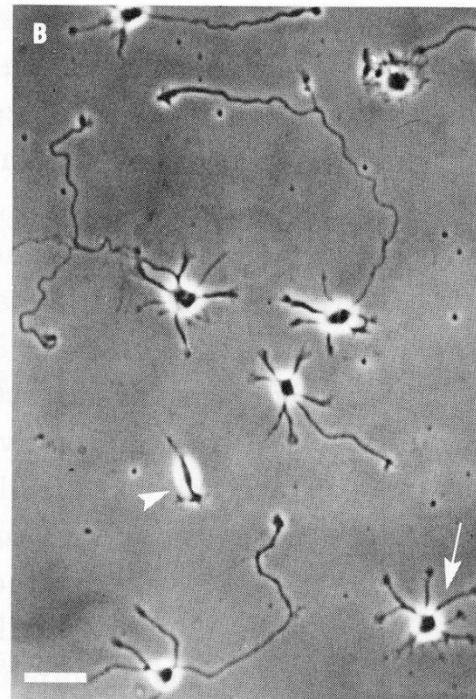
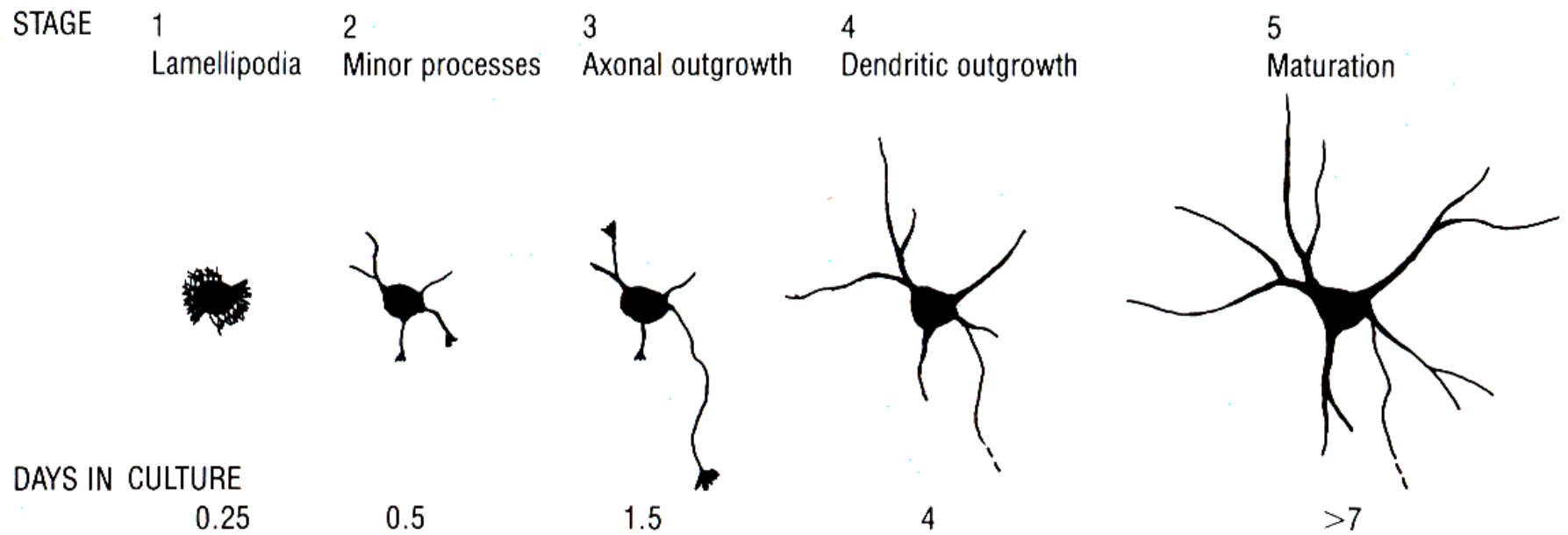




high-frequency stimulation applied to channel 1 only

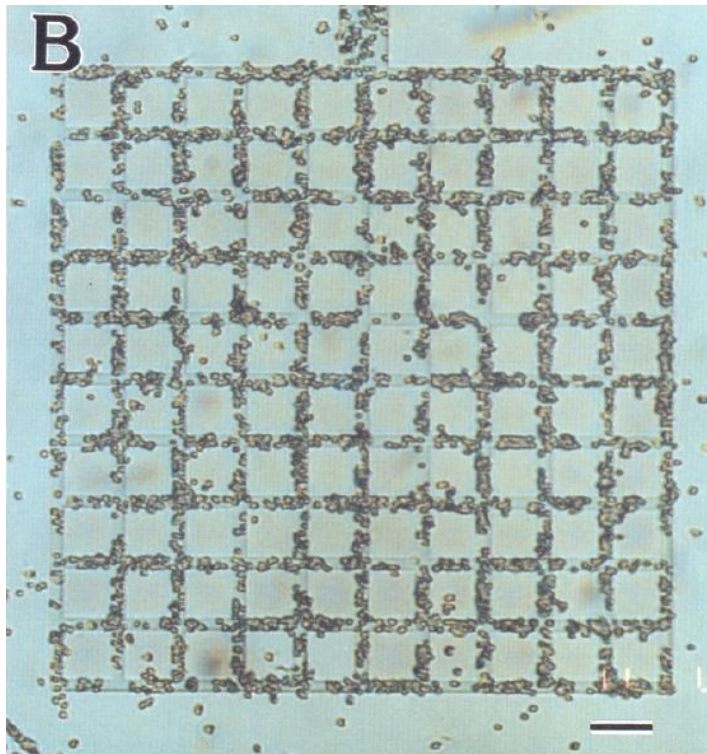
Casadio, A., *et al*, A transient, neuron-wide form of CREB-mediated long-term facilitation can be stabilized at specific synapses by local protein synthesis, *Cell*, **99**:221-37 (1999).



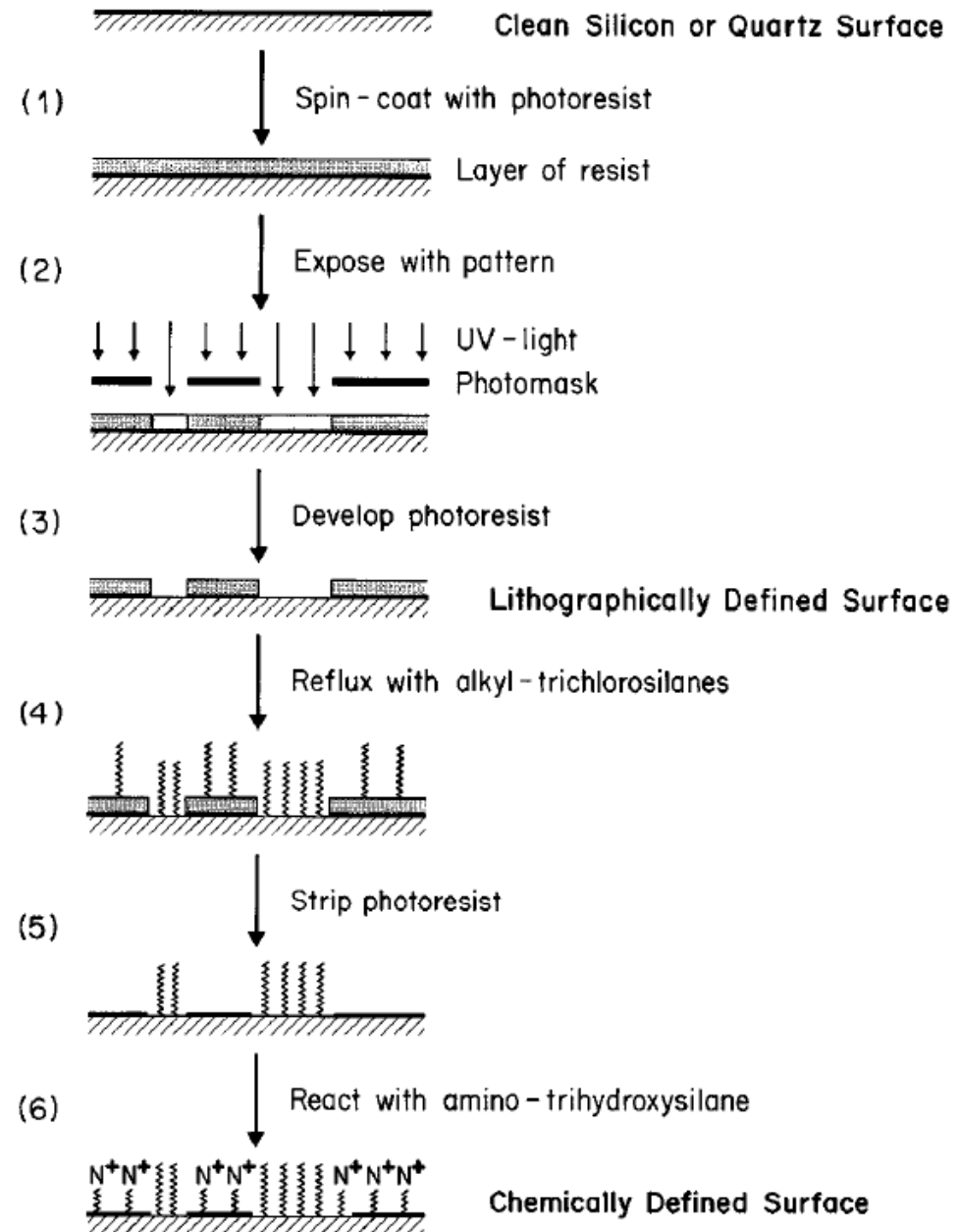


Patterning of positively-charged, adhesive molecules

- Kleinfeld method (1988)

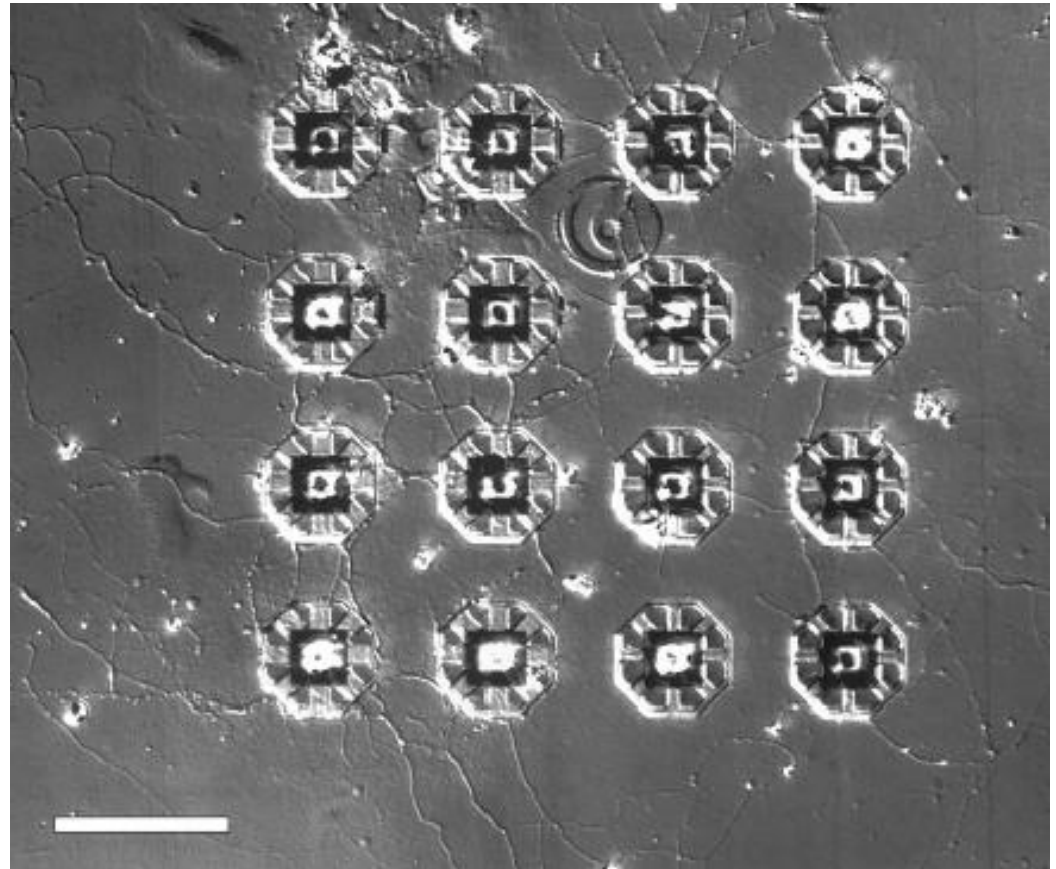
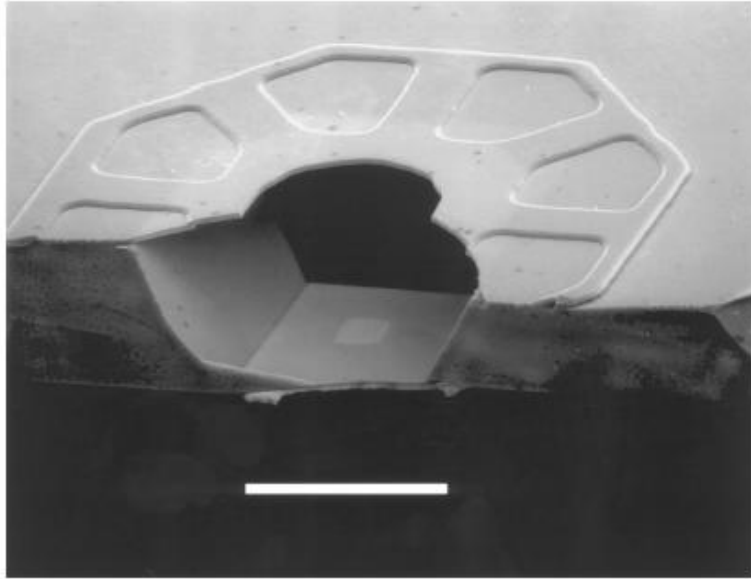


100 μm



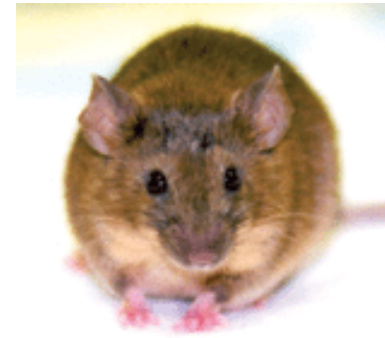
Neurocages:

Maher, M. P.; Pine, J.; Wright, J.; Tai, Y. C. *Journal of Neuroscience Methods*, **87**: 45-56 (1999)





Judah Folkman



Donald E.
Ingber



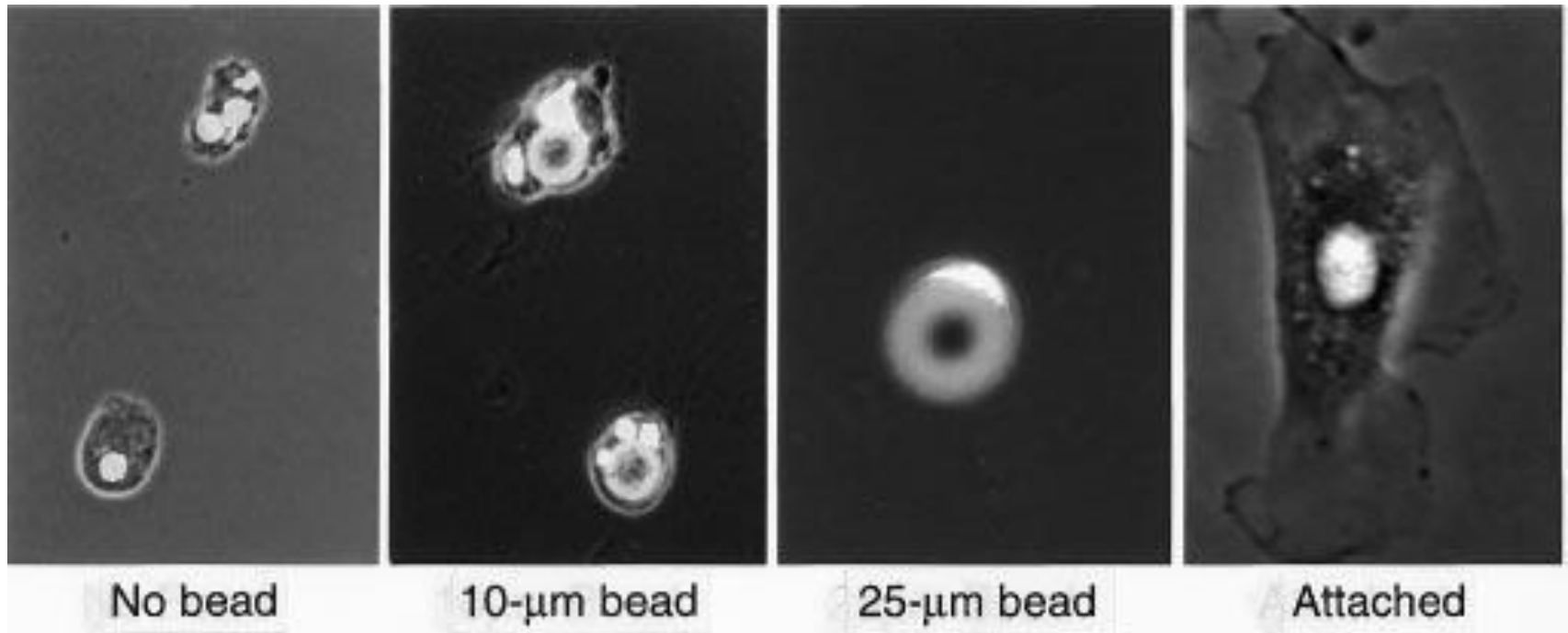
George M. Whitesides



Chris S. Chen



- Capillary endothelial cells were seeded onto either flat fibronectin-coated plates or beads of different diameter.
- Cells entered apoptosis as bead size decreased.

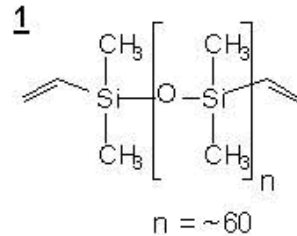


- A collection of techniques heavily employing elastomeric substrates to define patterns.
- The methods include microcontact printing, molding, embossing, and many, many, many variants.
- Microcontact printing was the beginning of all this:
A. Kumar, G.M. Whitesides, *Appl. Phys. Lett.* **1993**, 63, 2002.

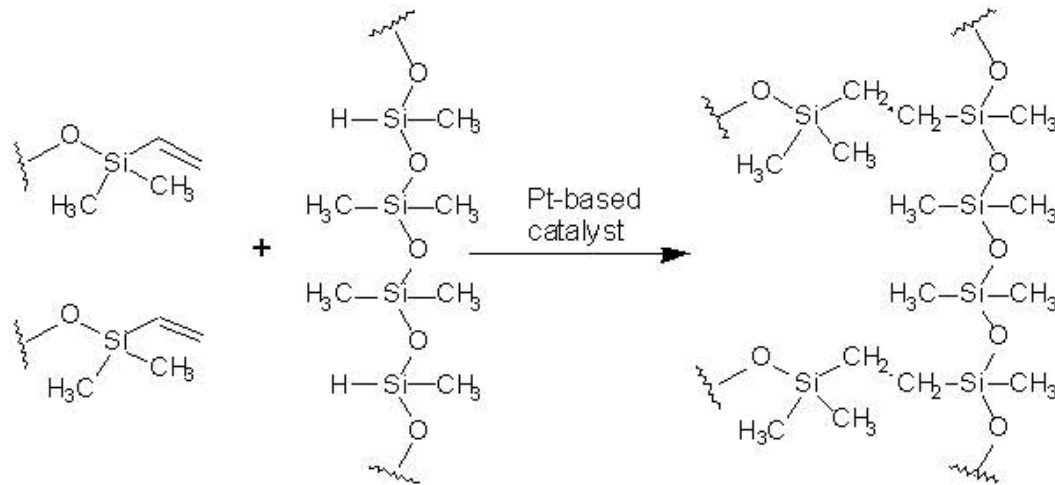
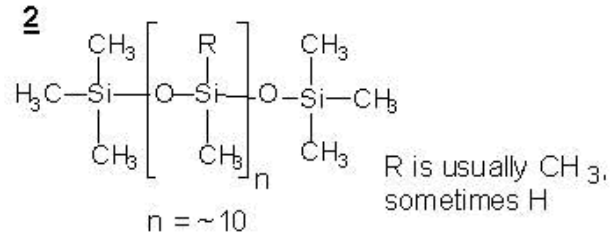


polydimethylsiloxane (PDMS)

siloxane oligomers

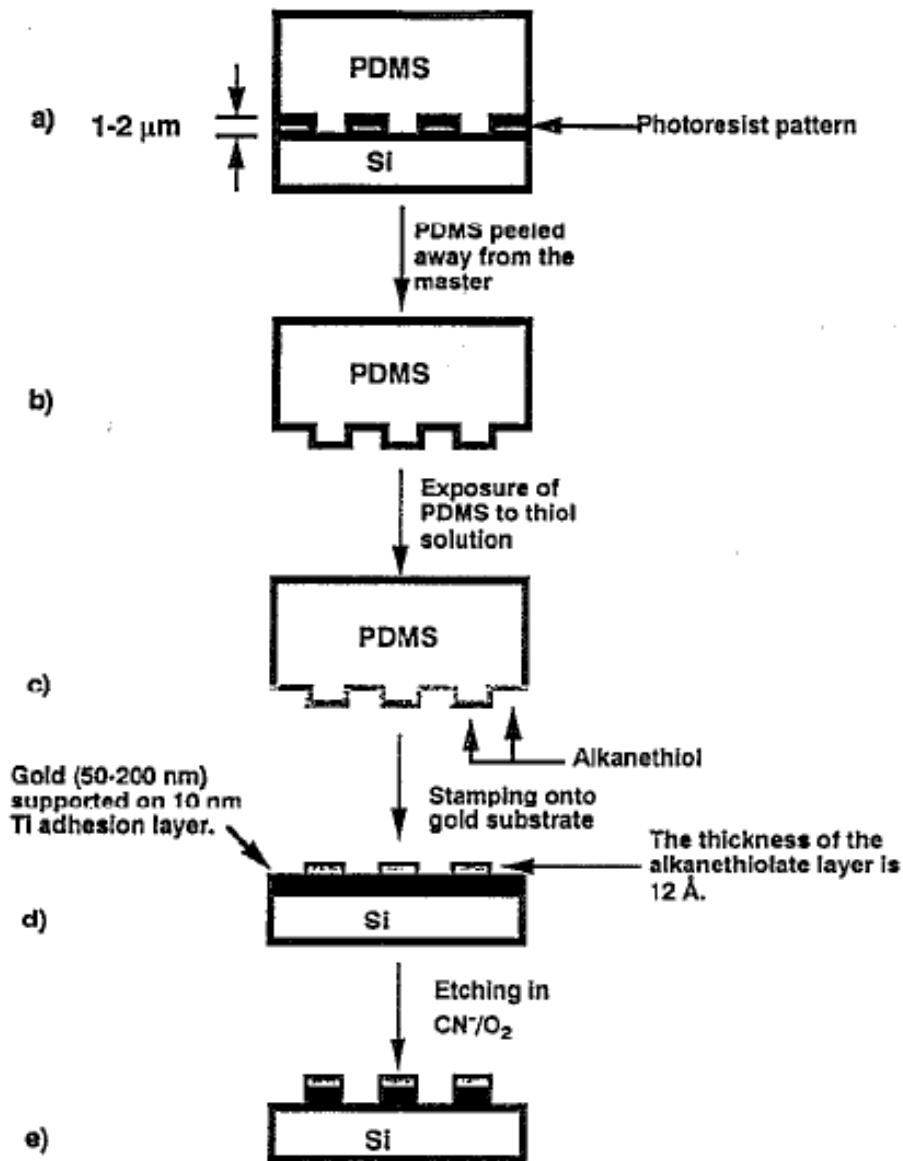


siloxane cross-linkers



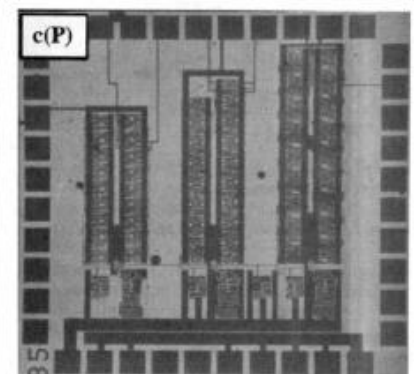
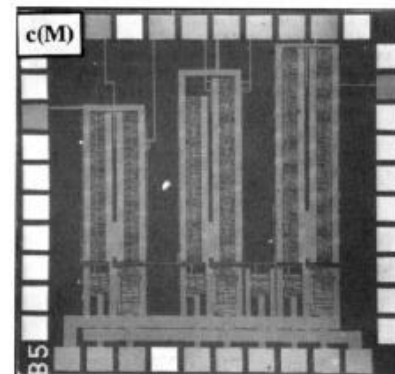
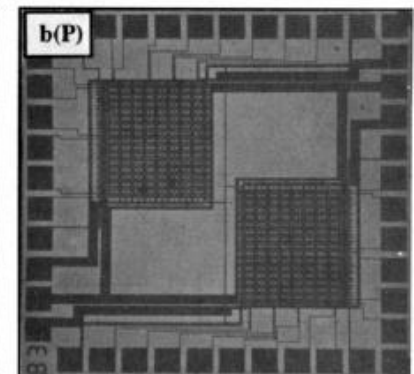
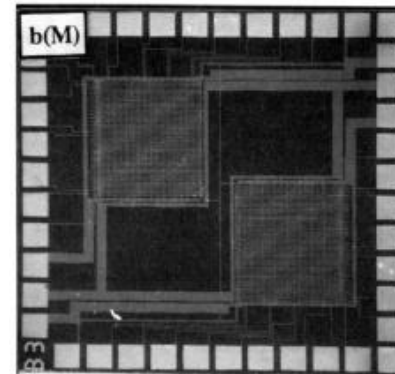
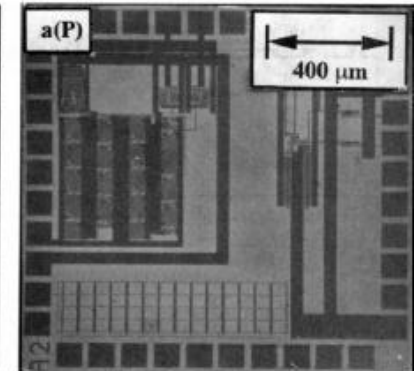
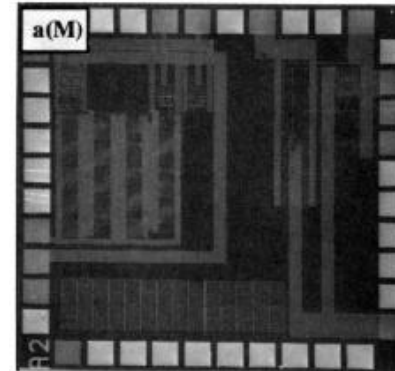
- Controllable mechanical properties
- Most often used: Dow Corning Sylgard 184, 182
- cures without shrinking and without solvents

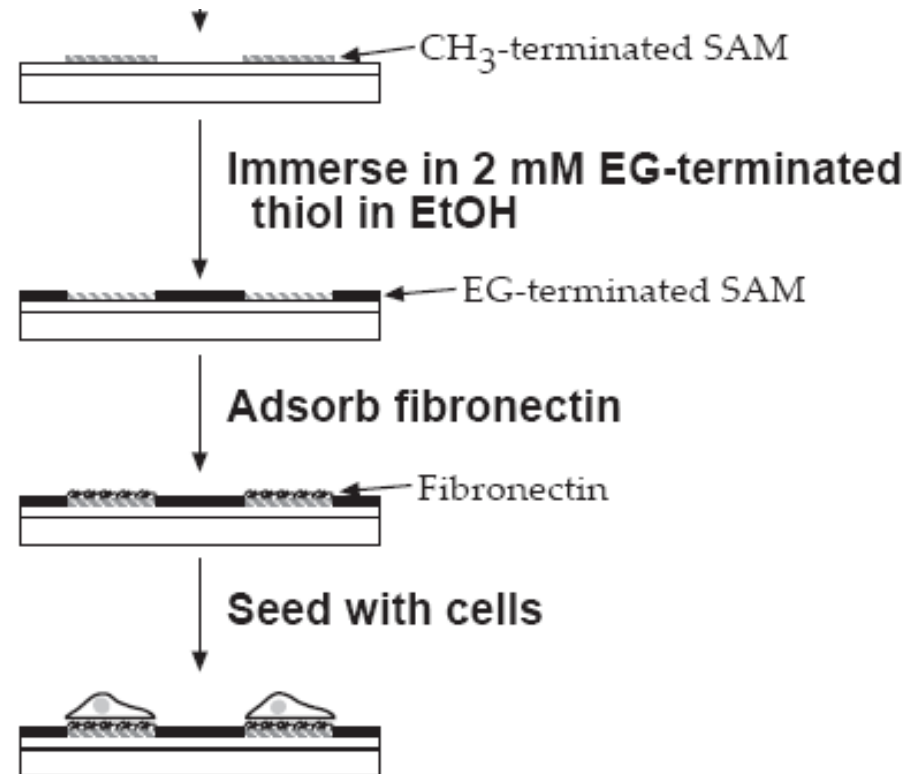
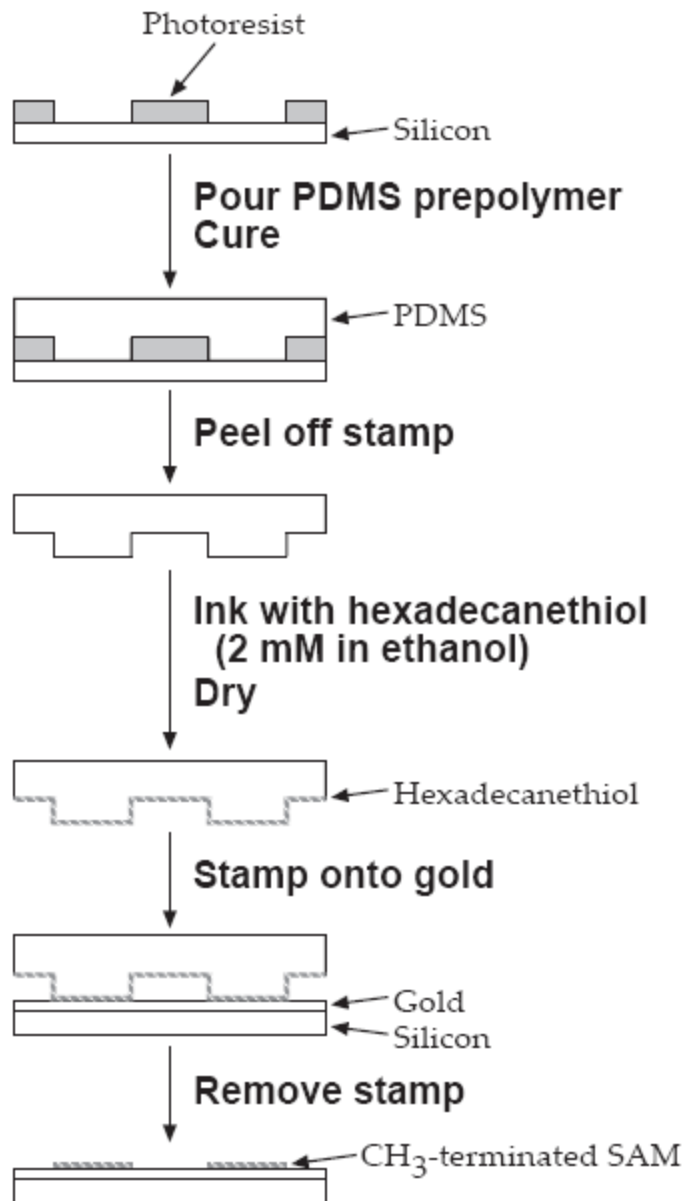
Patterning thiols - Kumar & Whitesides, 1993



master

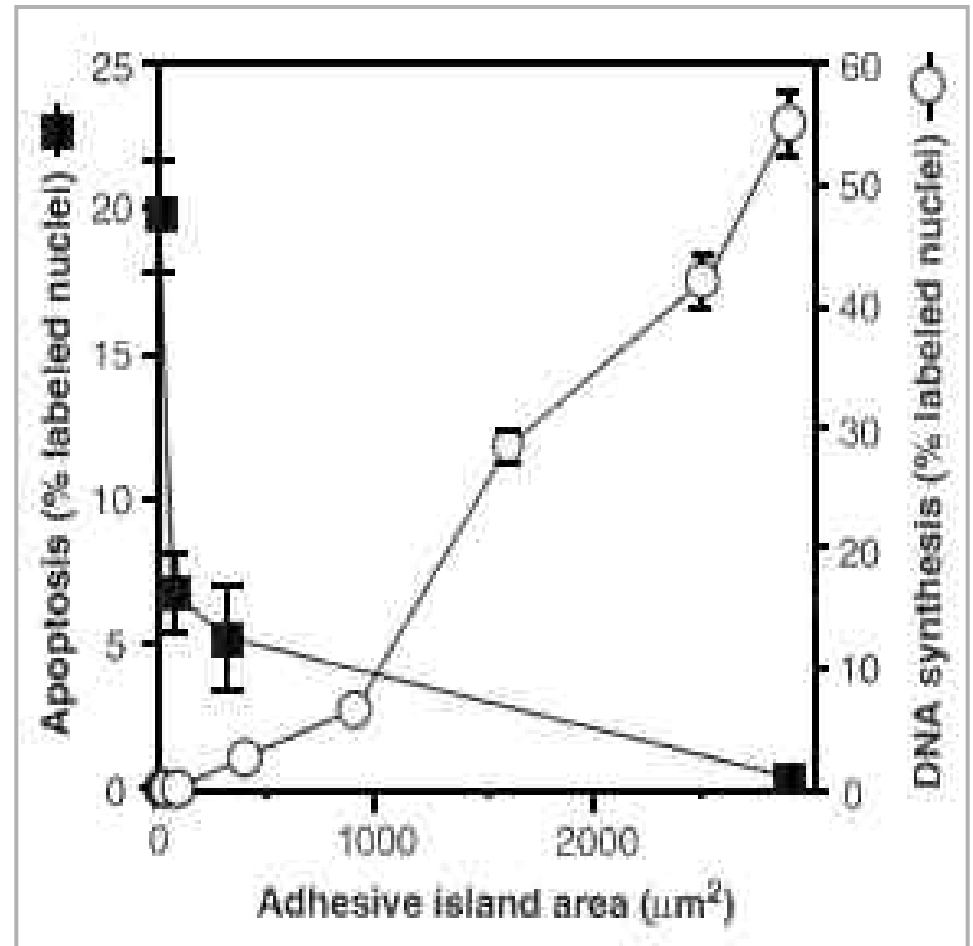
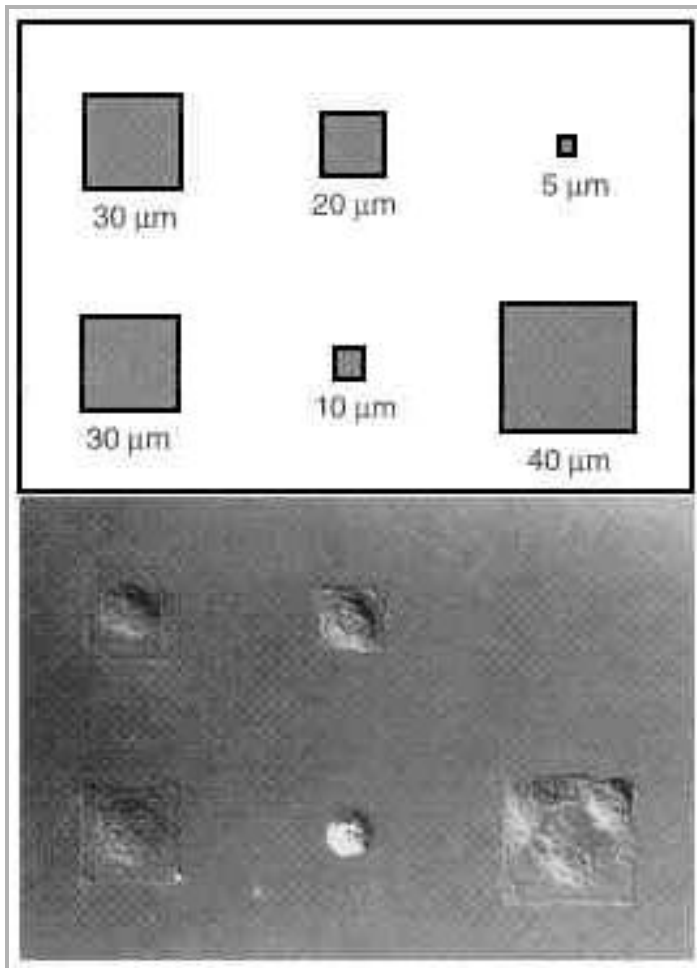
etched pattern



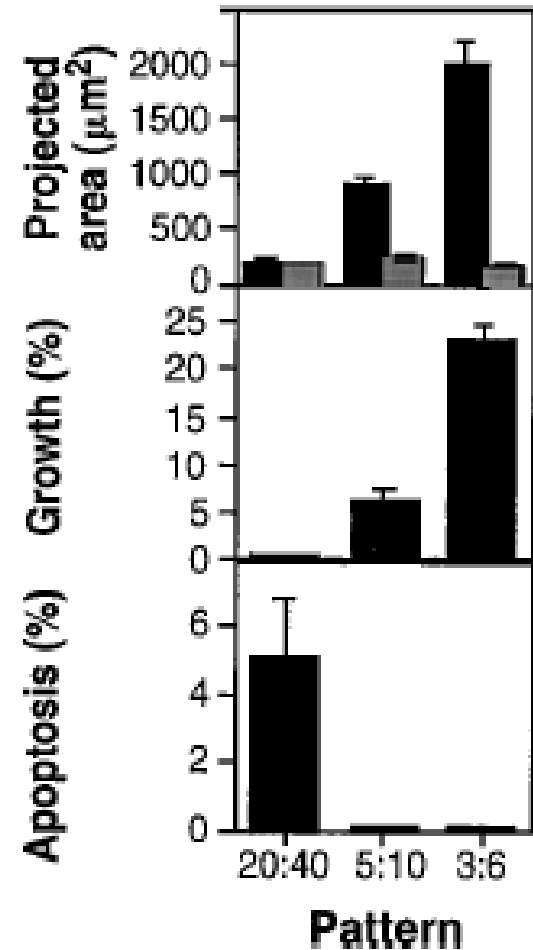
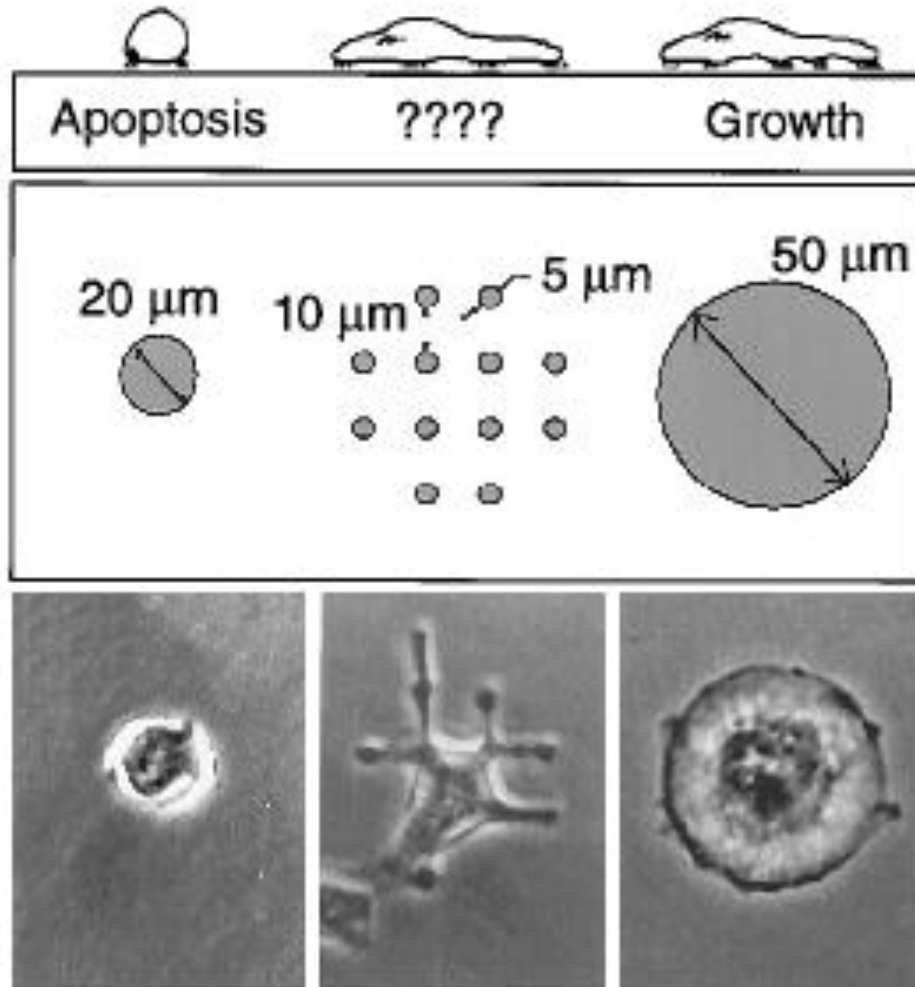


- first, stamped hexadecanethiol [HS(CH₂)₁₅CH₃]
- then, washed with tri(ethylene glycol)-terminated-alkanethiol HS(CH₂)₁₁(OCH₂CH₂)₃OH

Cell spreading regulates cell survival



Cell spreading regulates cell survival

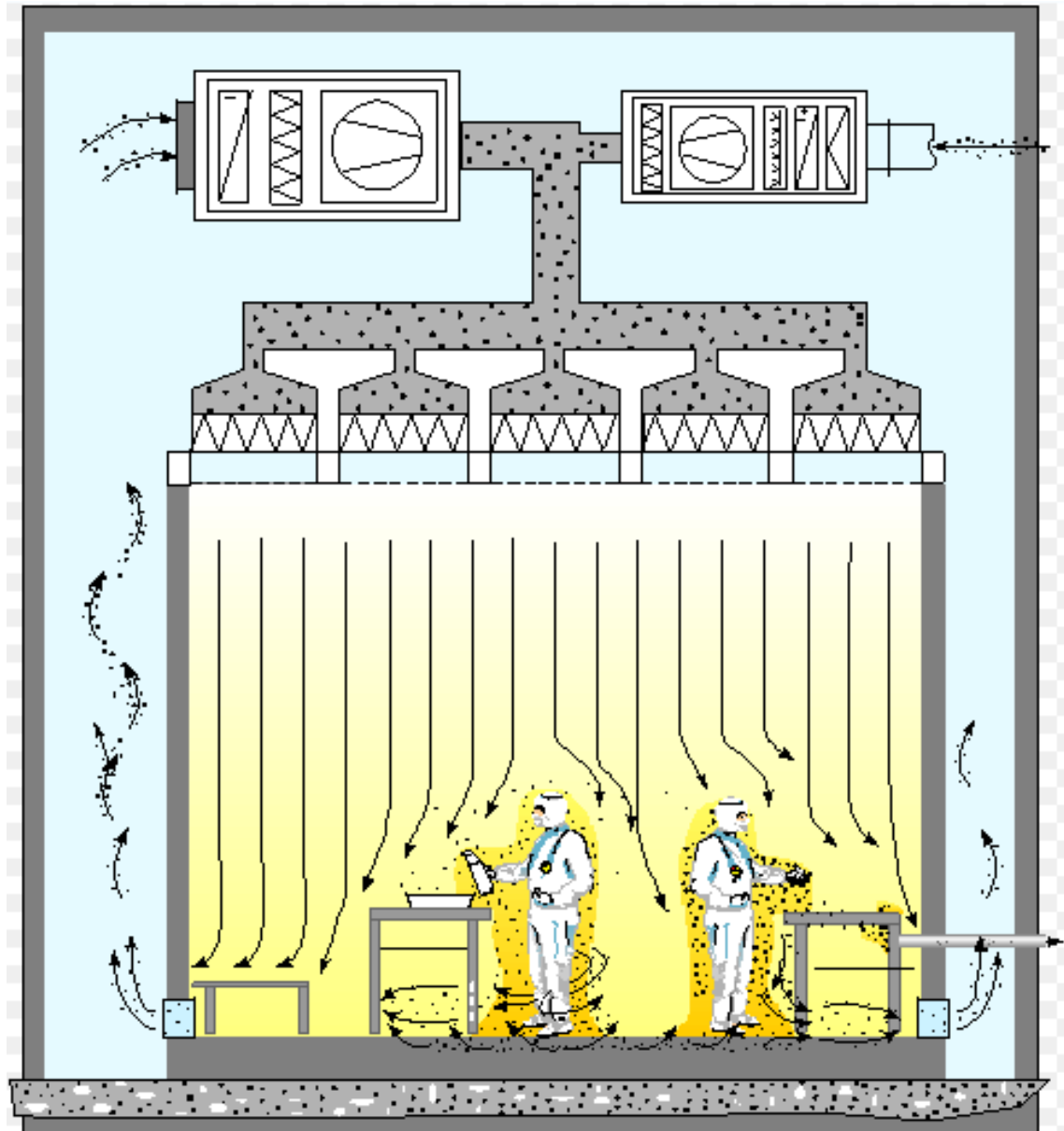


black bars: total area
grey bars: ECM contact

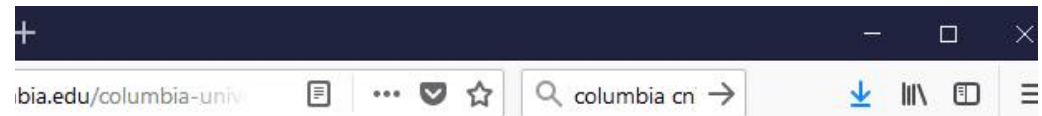
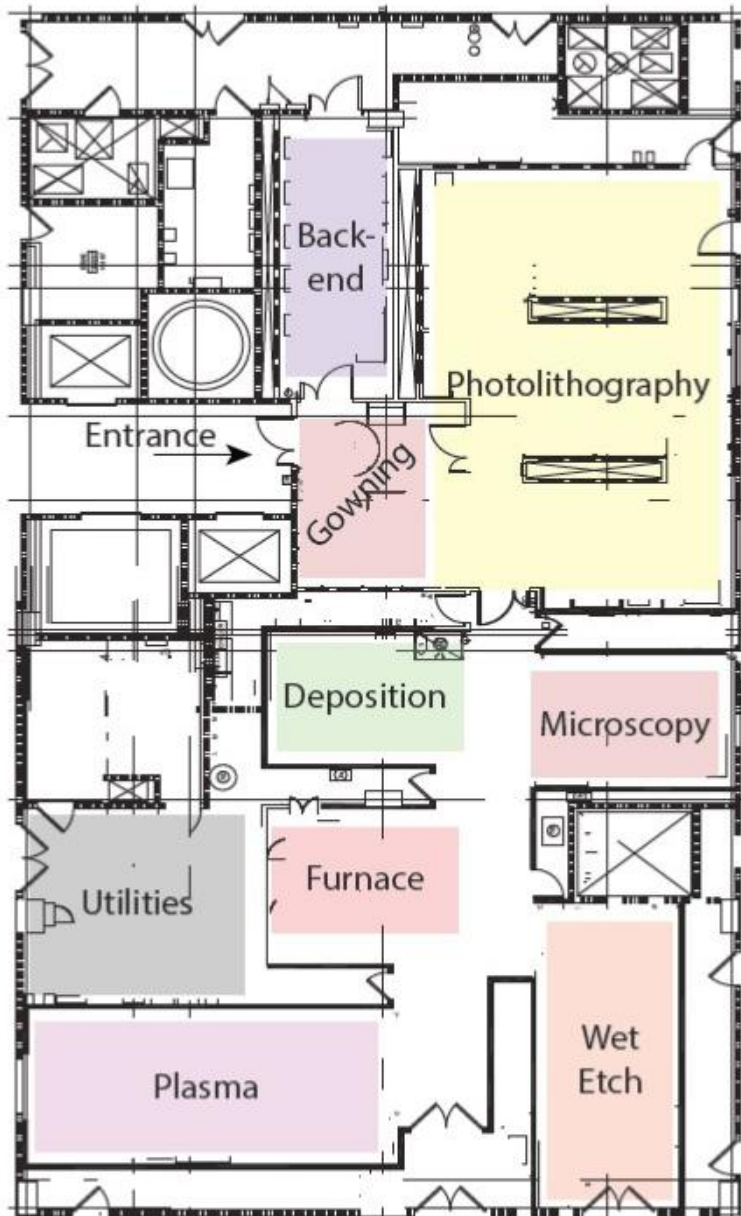
Clean room



Clean room



Columbia Clean room - <http://cni.columbia.edu/columbia-university-clean-room/>



COLUMBIA NANO INITIATIVE

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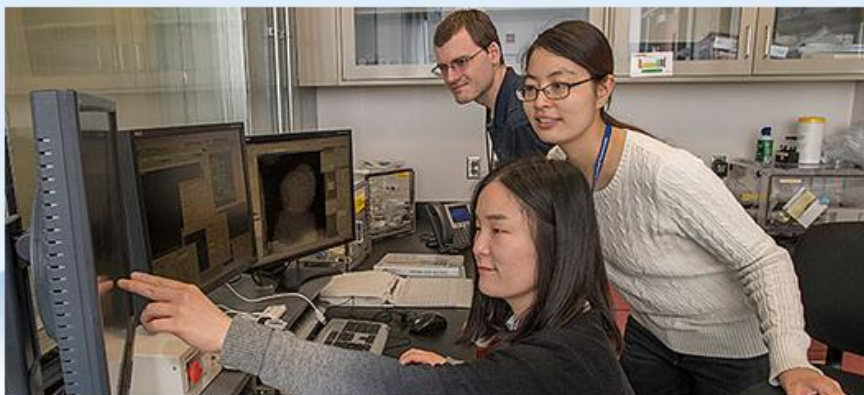
BROOKHAVEN
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Center for Functional Nanomaterials
An Office of Science User Facility



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