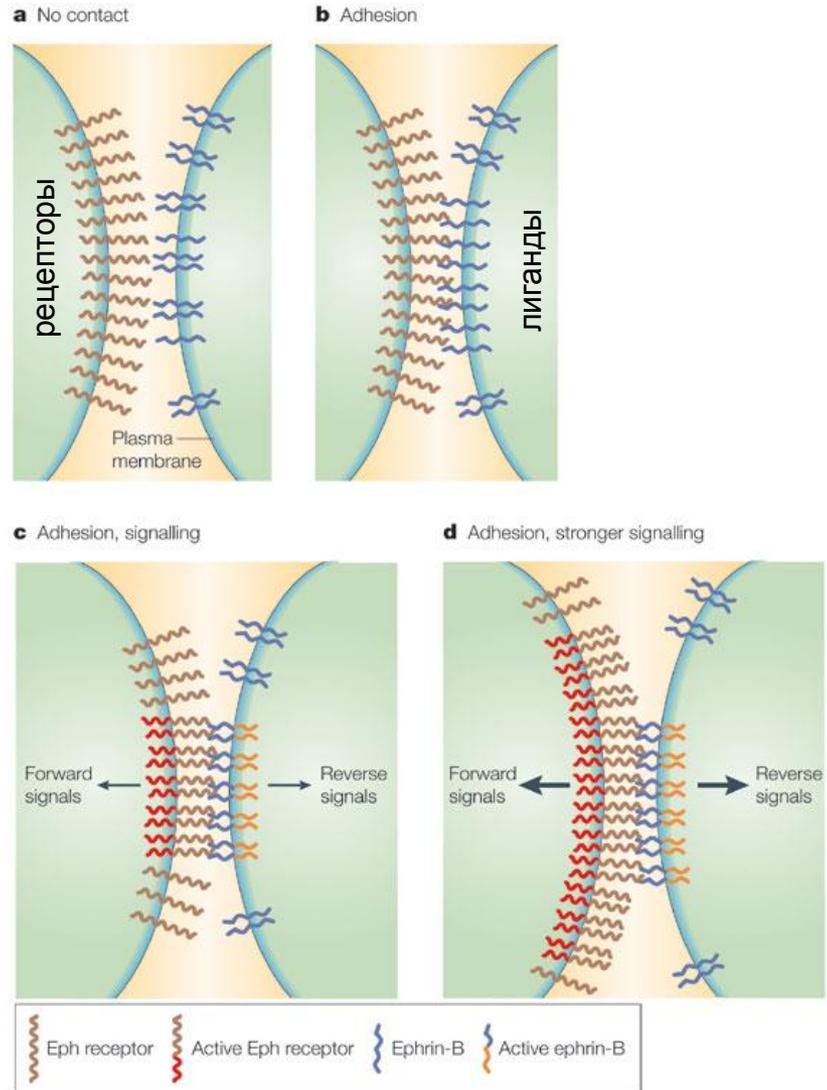
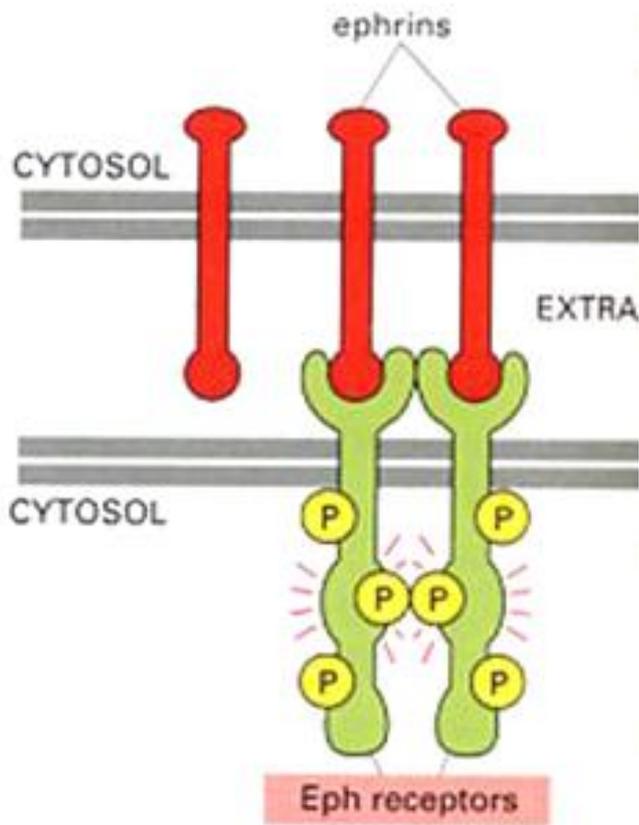
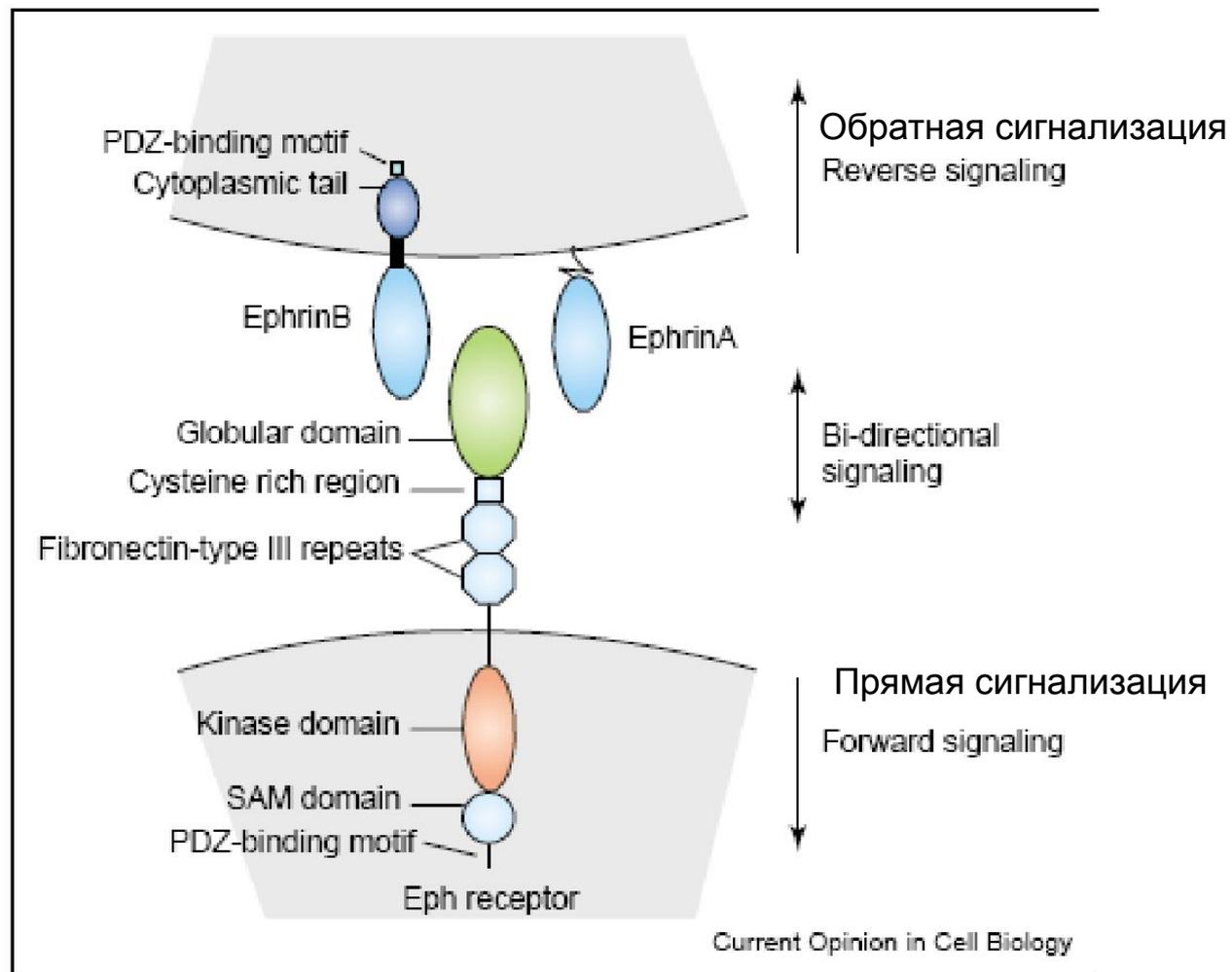


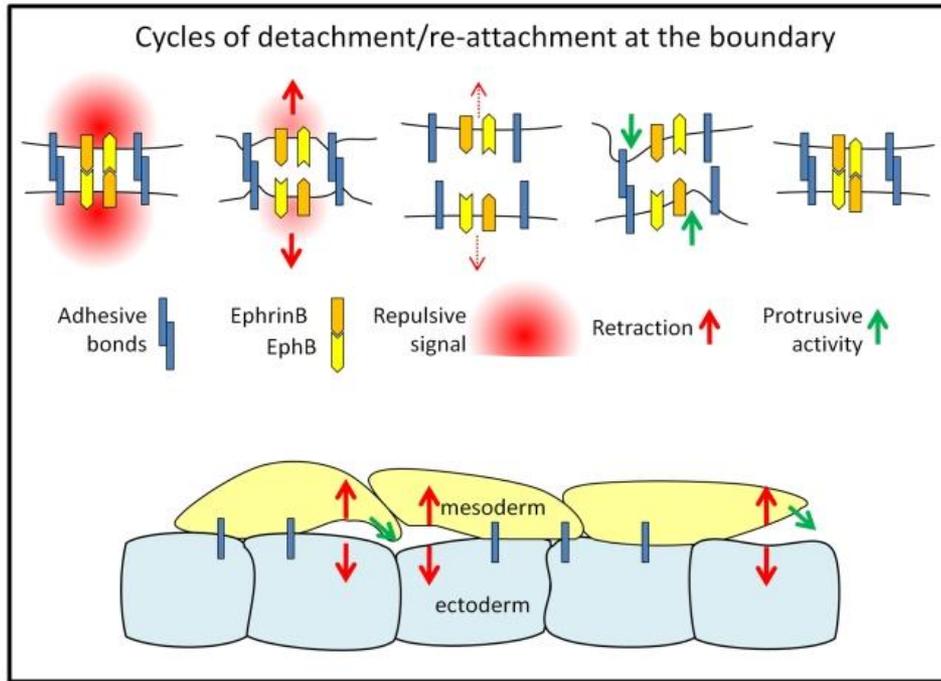
АКТИВАЦИЯ ЭФРИНОВ ПУТЕМ ИХ КЛАСТЕРИЗАЦИИ



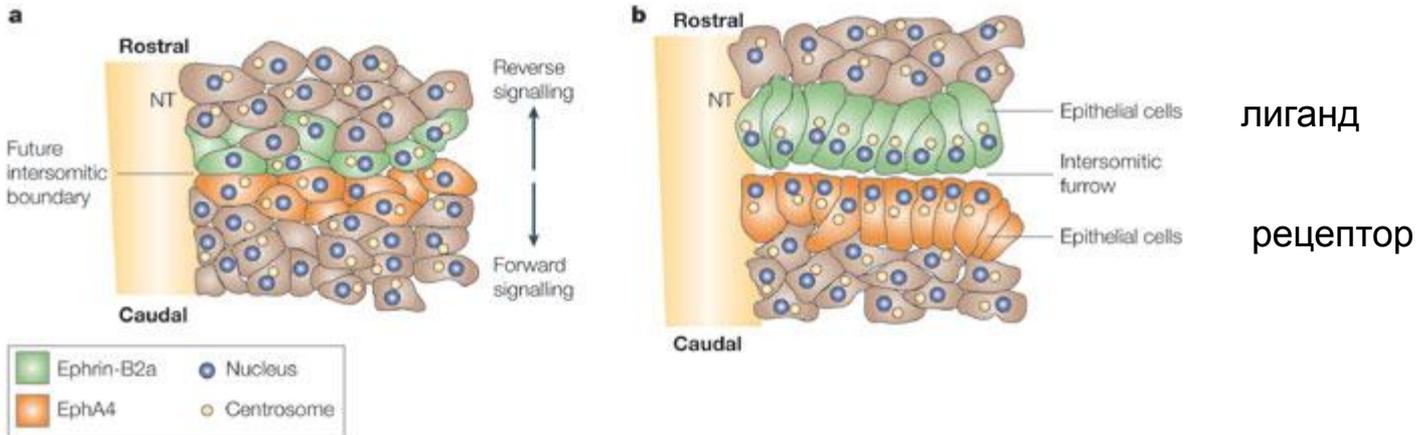
ДВУНАПРАВЛЕННАЯ СИГНАЛИЗАЦИЯ ЧЕРЕЗ ЭФРИНЫ



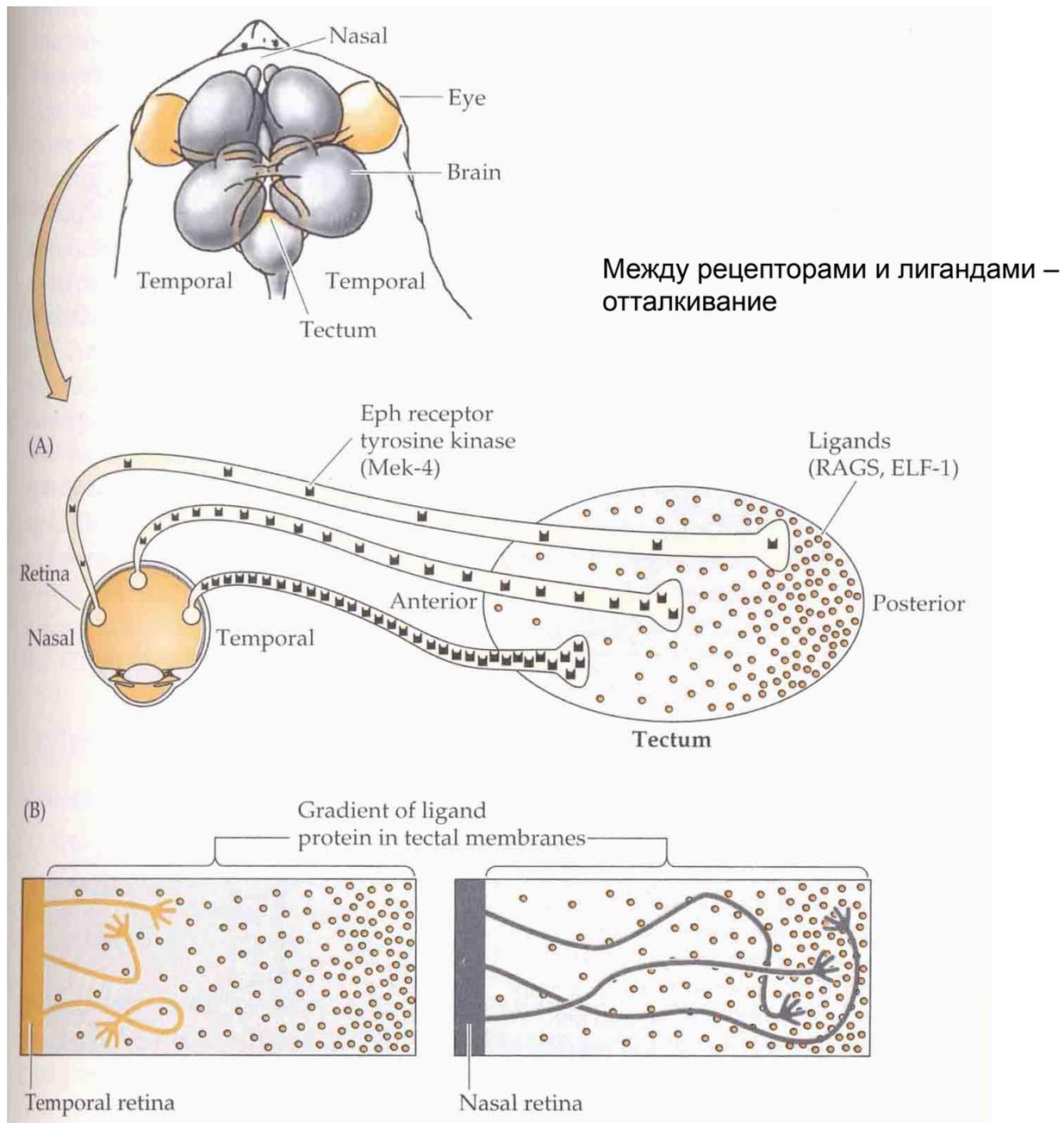
Циклы отталкивания – прикрепления на экто-мезодермальной границе



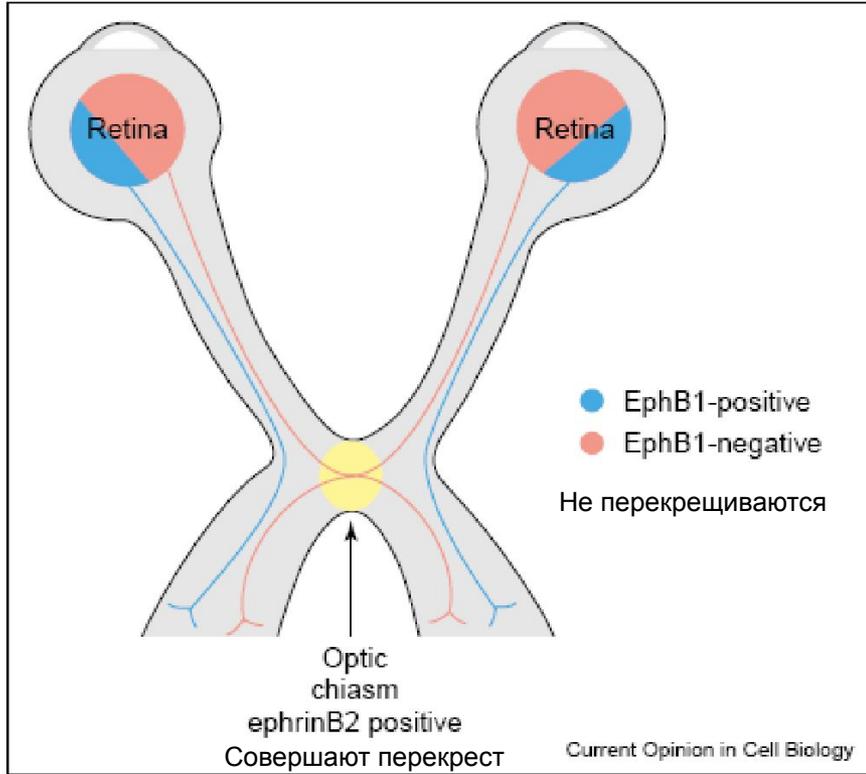
Установление межсомитных границ



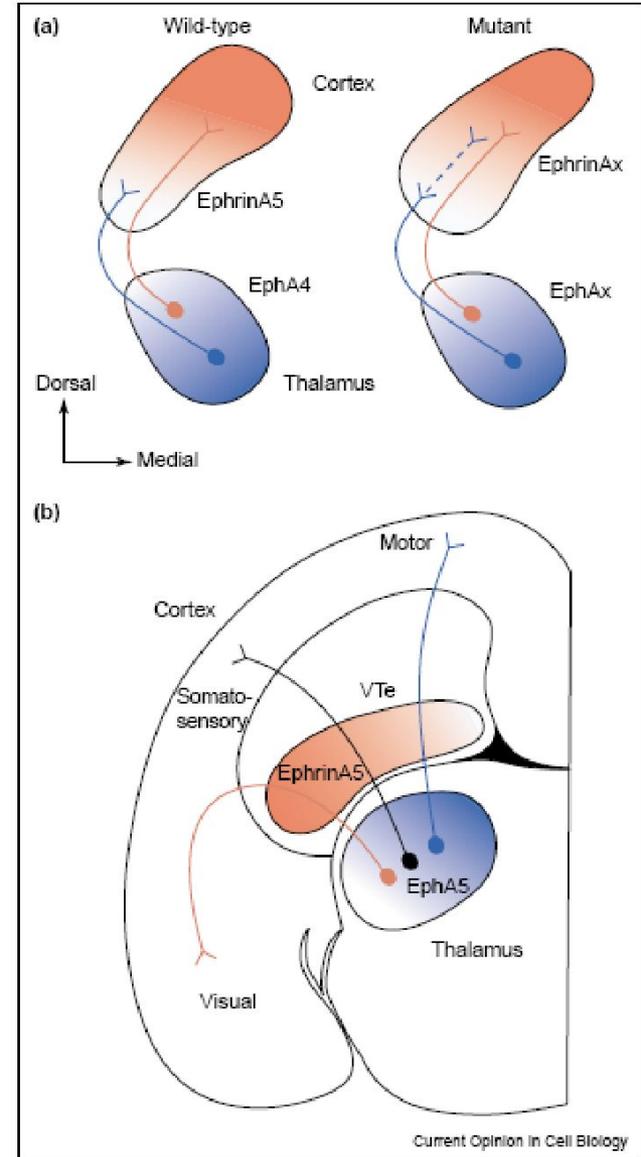
РЕТИНО-ТЕКТАЛЬНАЯ ПРОЕКЦИЯ



Роль эфриновой сигнализации в перекресте волокон зрительного нерва

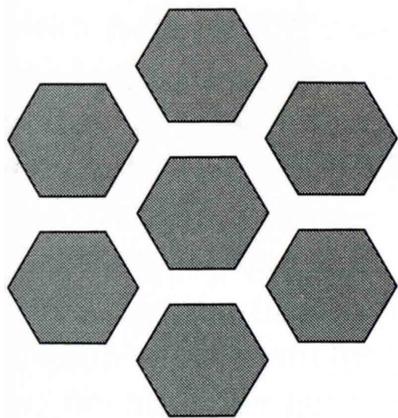


Путь от зрительных бугров к коре

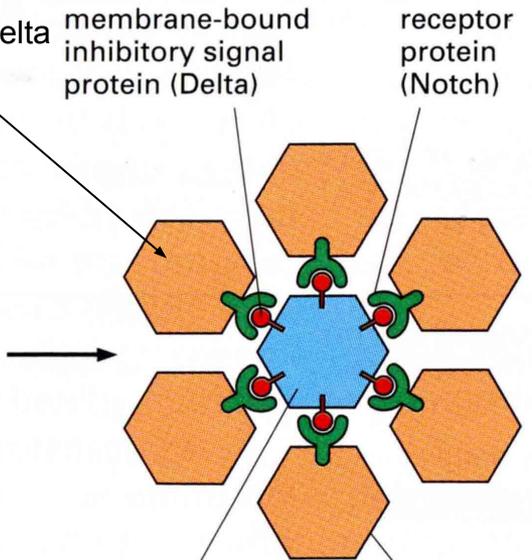


СИГНАЛИЗАЦИЯ DELTA – NOTCH: ВЗАИМОДЕЙСТВИЕ МЕМБРАННО-СВЯЗАННОГО ЛИГАНДА DELTA (КРАСНЫЙ) НА ПОВЕРХНОСТИ БУДУЩИХ НЕРВНЫХ КЛЕТК С РЕЦЕПТОРОМ NOTCH, ПРИВОДЯЩЕЕ К РАСЩЕПЛЕНИЮ ПОСЛЕДНЕГО И ПОДАВЛЕНИЮ НЕЙРАЛЬНОЙ ДИФФЕРЕНЦИРОВКИ В СЛЕДУЮЩЕМ РЯДУ КЛЕТОК

Подавление активности собственных Delta



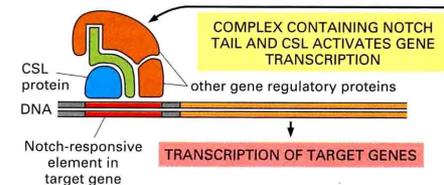
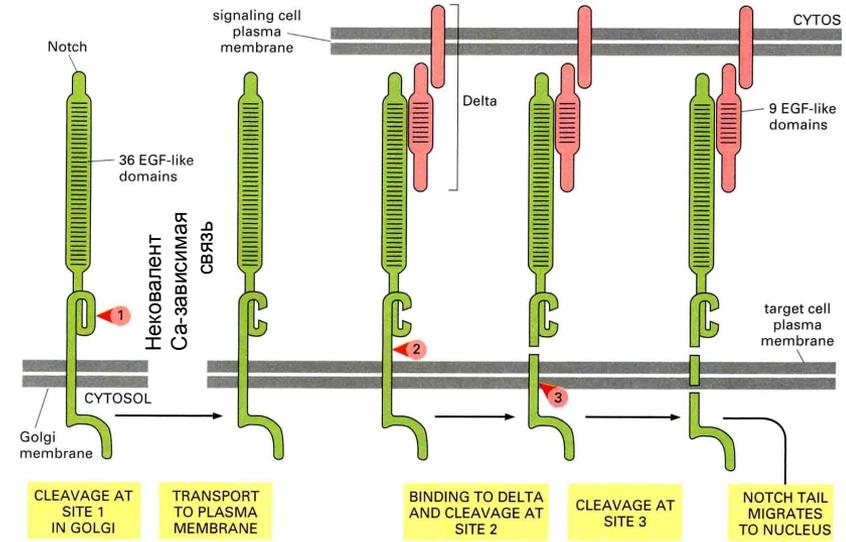
unspecified epithelial cells

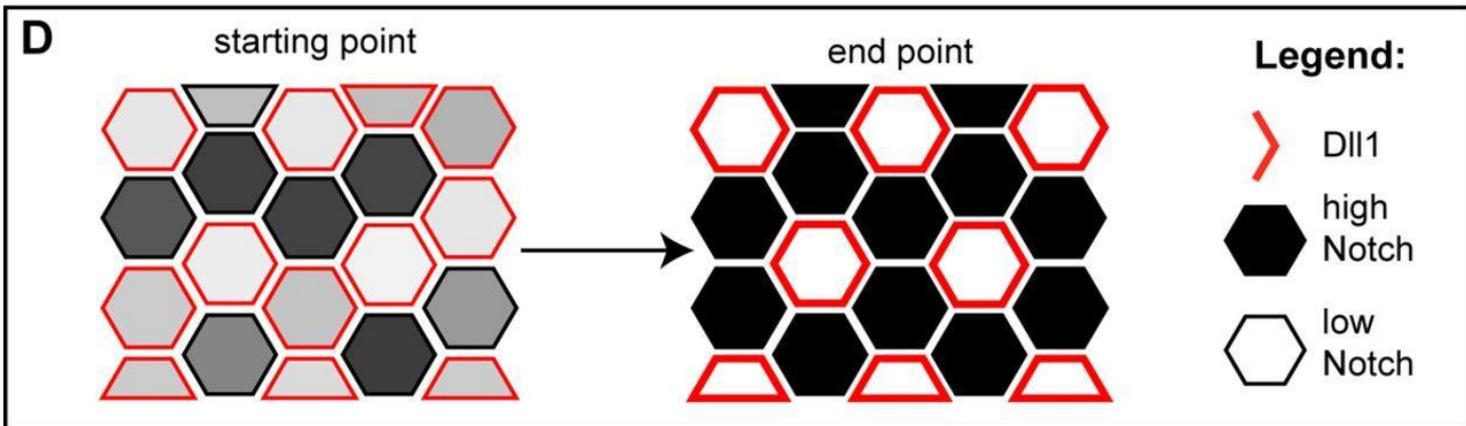
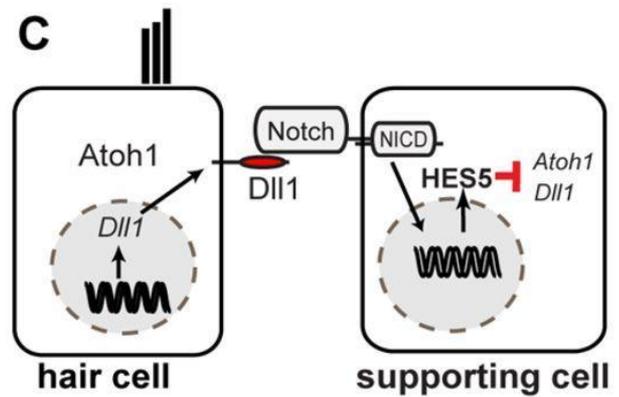
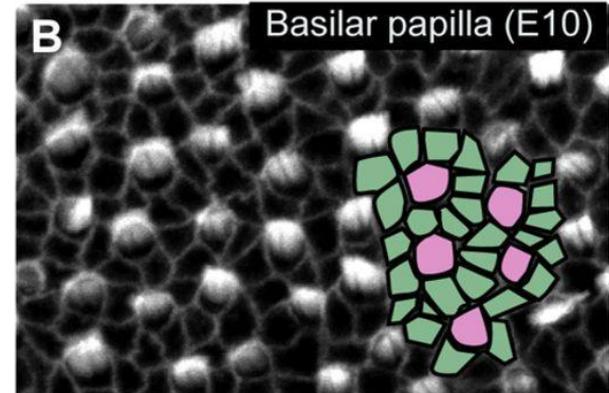
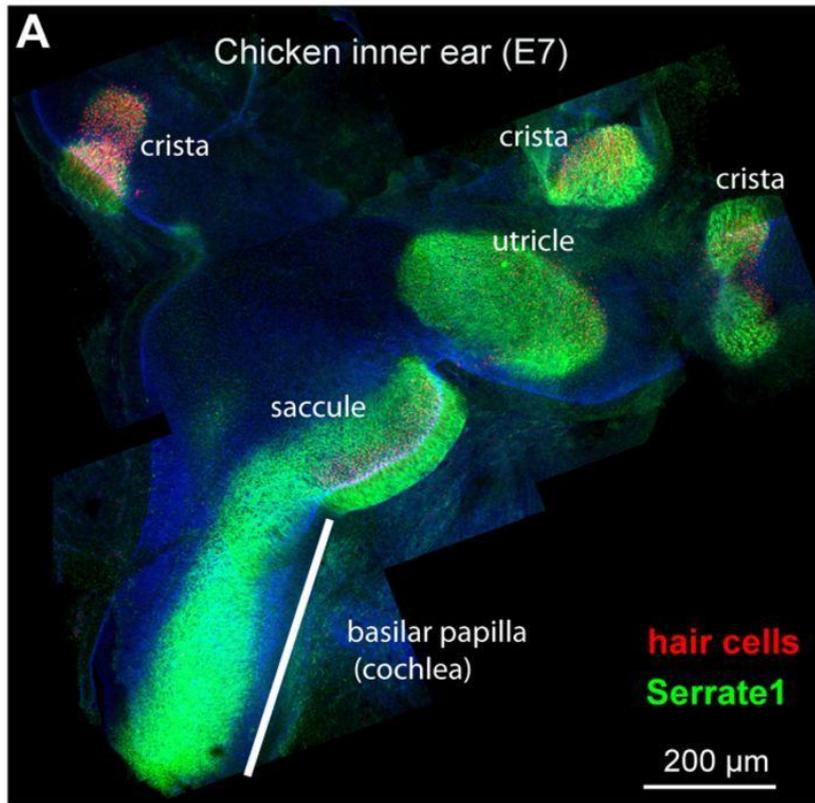


nerve cell developing from epithelial cell

inhibited epithelial cell

membrane-bound inhibitory signal protein (Delta)
receptor protein (Notch)





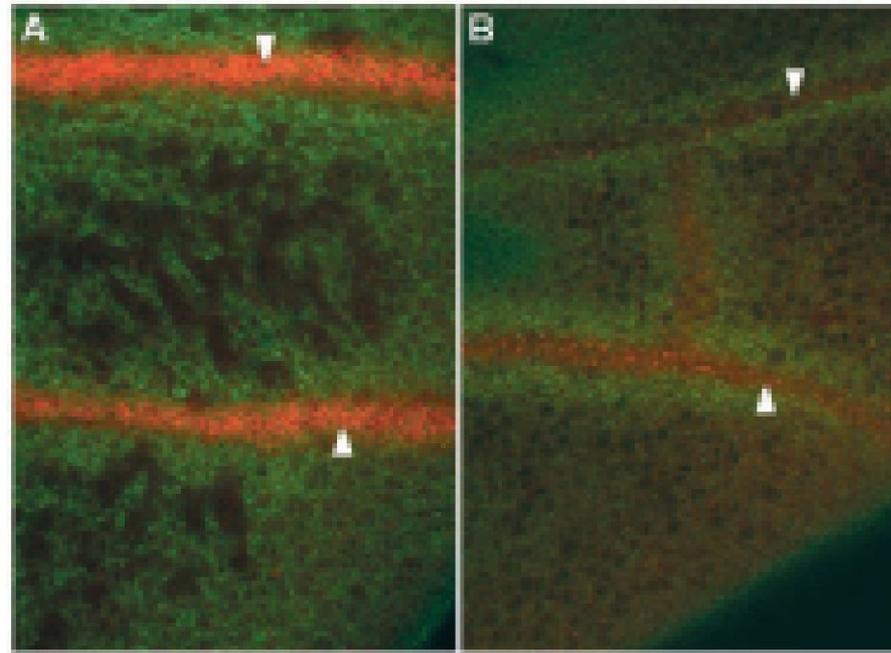
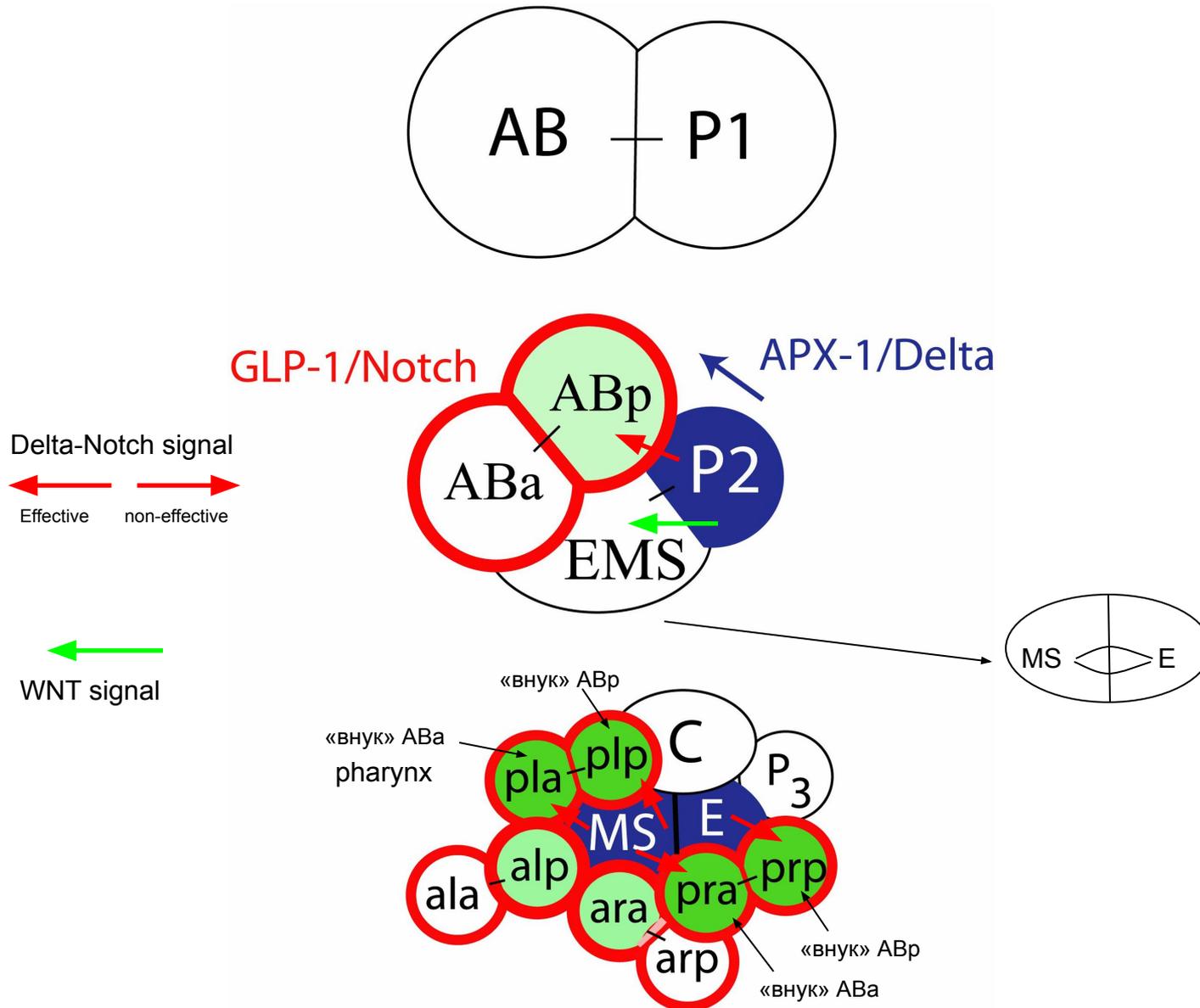


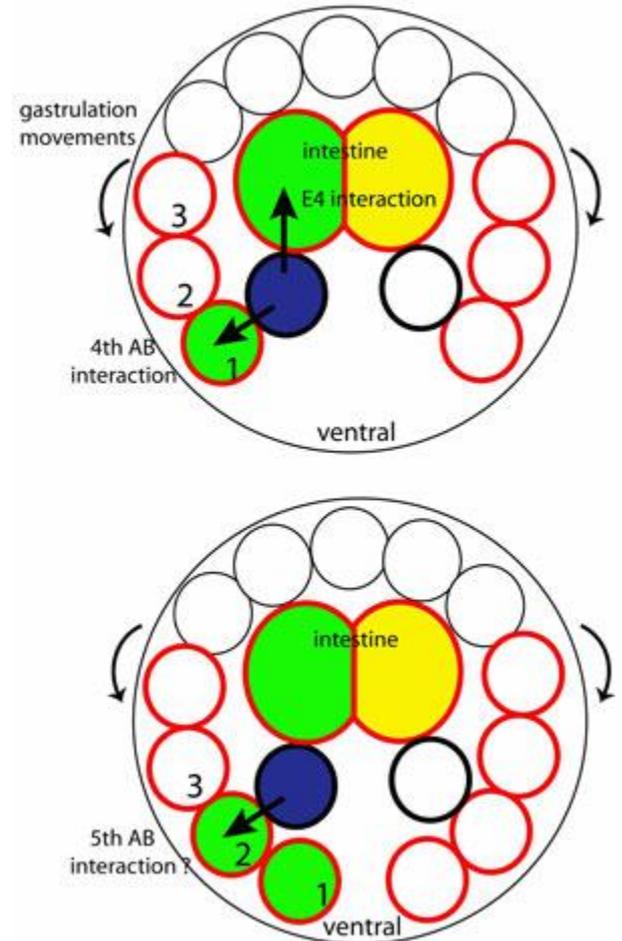
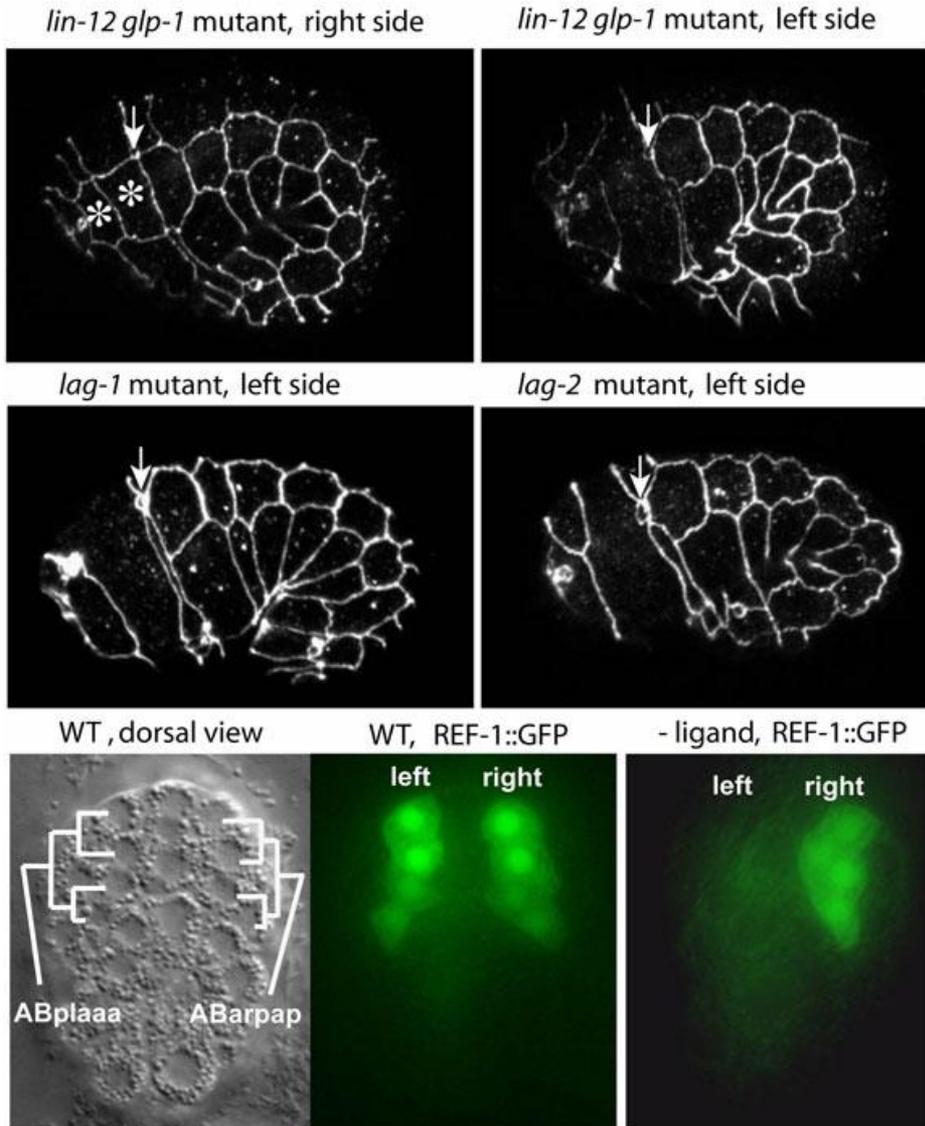
Fig. 3. Delta and Notch protein expression in pupal wing discs. Discs stained for Delta and Notch, as described in Materials and Methods. Delta signal, red; Notch signal, green. (A) 24 hour APF disc with presumptive L3 and L4 vein cells marked (Δ). (B) 30 hour APF disc with presumptive L4 and L5 vein cells marked (Δ).

DELTA-NOTCH и Wnt сигнализация в раннем развитии *C. elegans*

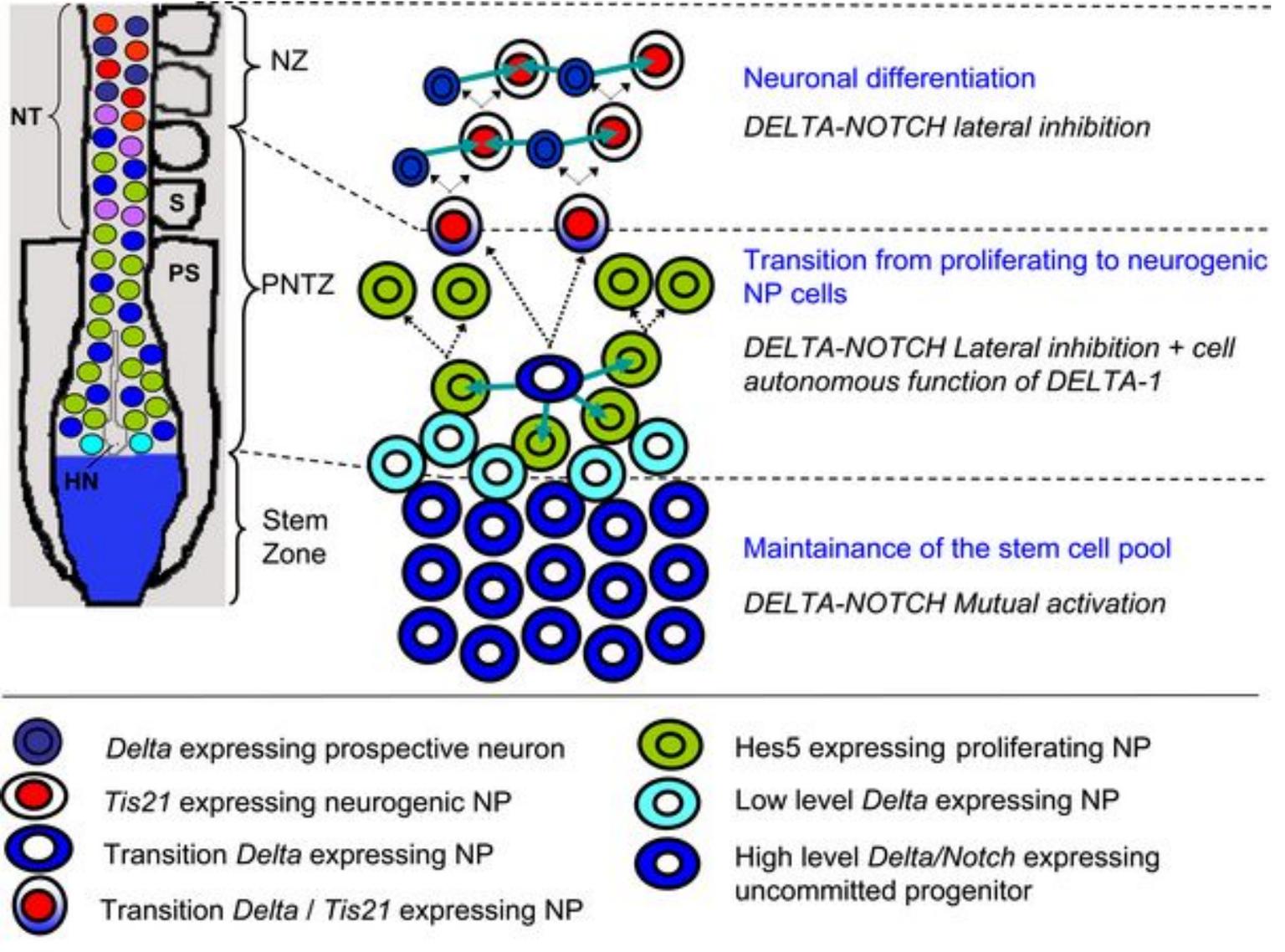


DELTA-NOTCH ИНДУКЦИИ В ПОЗДНЕМ РАЗВИТИИ C.ELEGANS

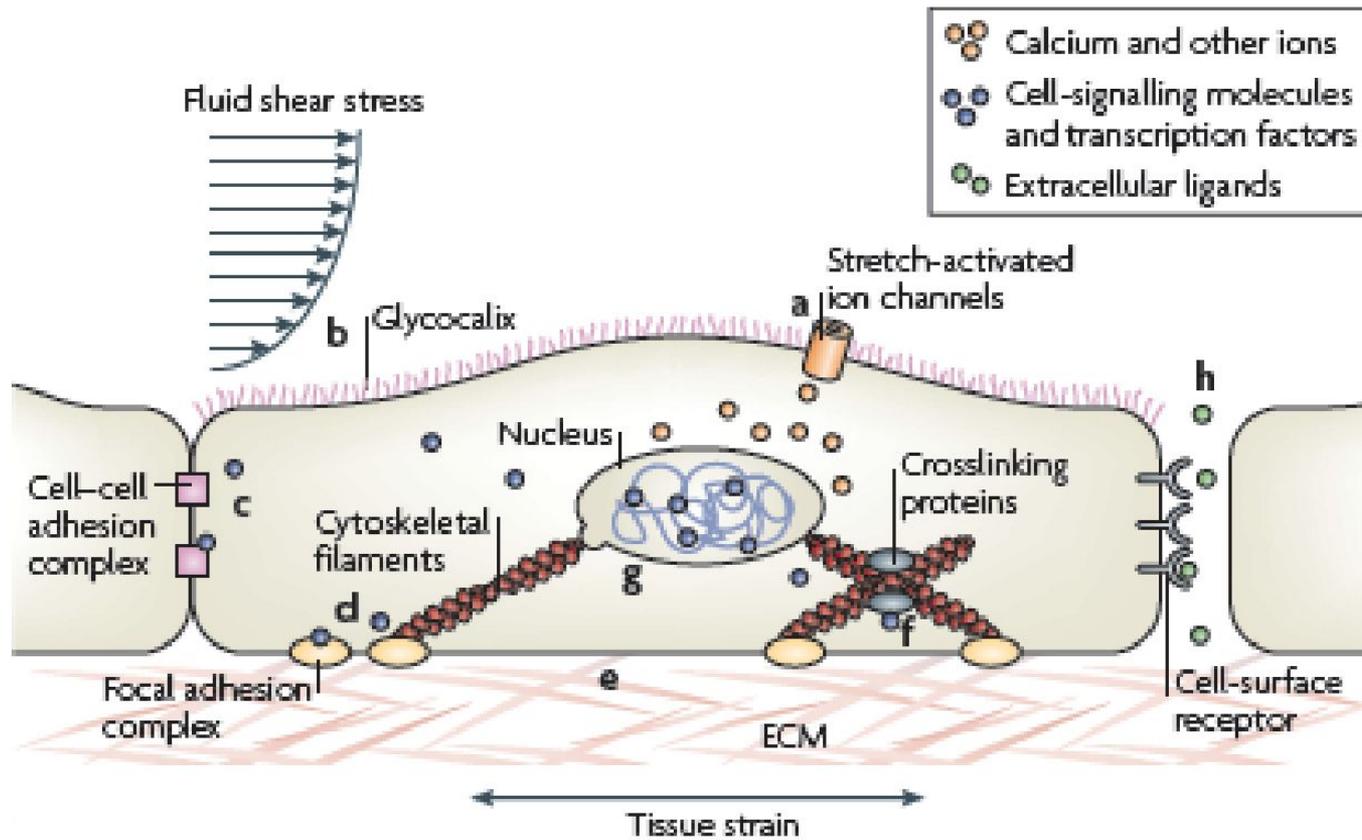
Для клеток левой стороны головы необходима индукция



- **Figure 9. A working model for the involvement of DELTA-NOTCH signalling in the transition from proliferation to neurogenesis in the developing chick spinal cord.**



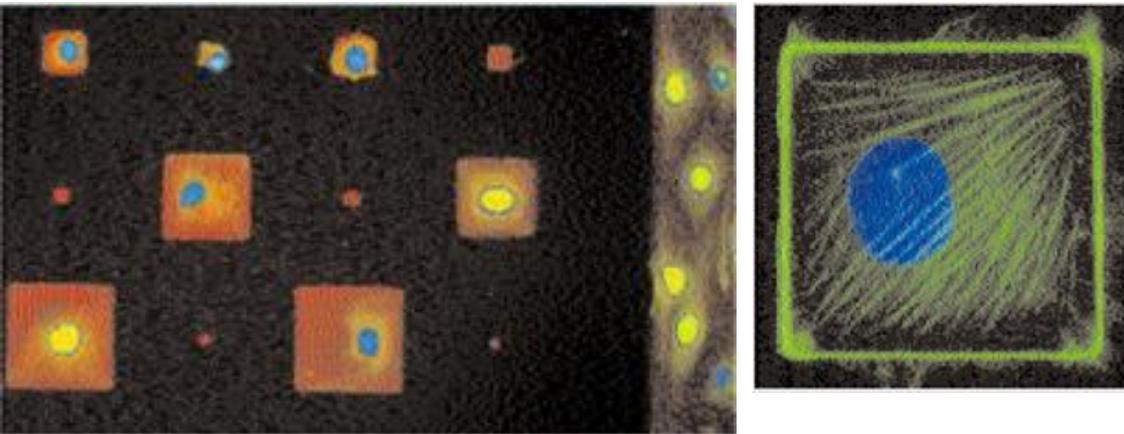
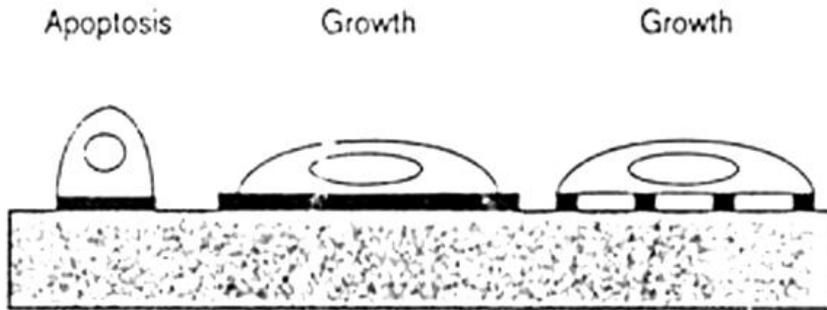
МЕХАНИЧЕСКИЕ СИЛЫ, ДЕЙСТВУЮЩИЕ НА КЛЕТКИ



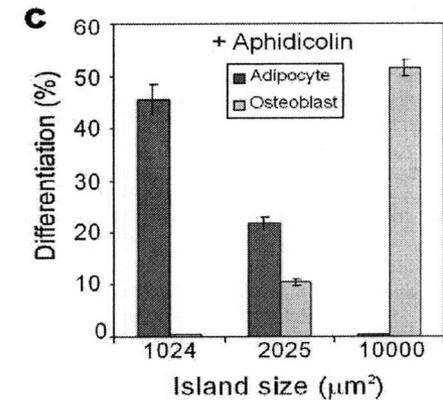
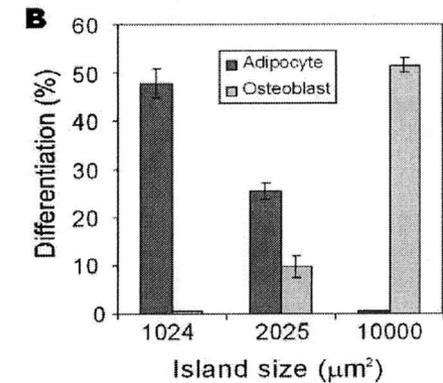
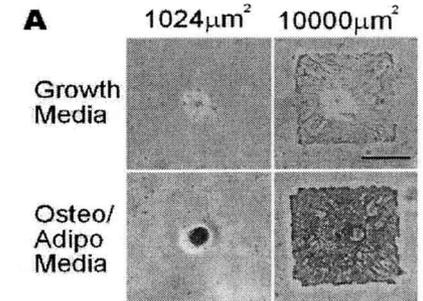
МЕХАНИЧЕСКИЕ НАПРЯЖЕНИЯ КАК ФАКТОР ВЫЖИВАНИЯ И ДИФФЕРЕНЦИРОВКИ: КЛЕТКИ НА «ОСТРОВКАХ»

Chen et al. *Geometric control of Cell life and death.*

Science (1997) 276. no. 5317:1425 - 1428

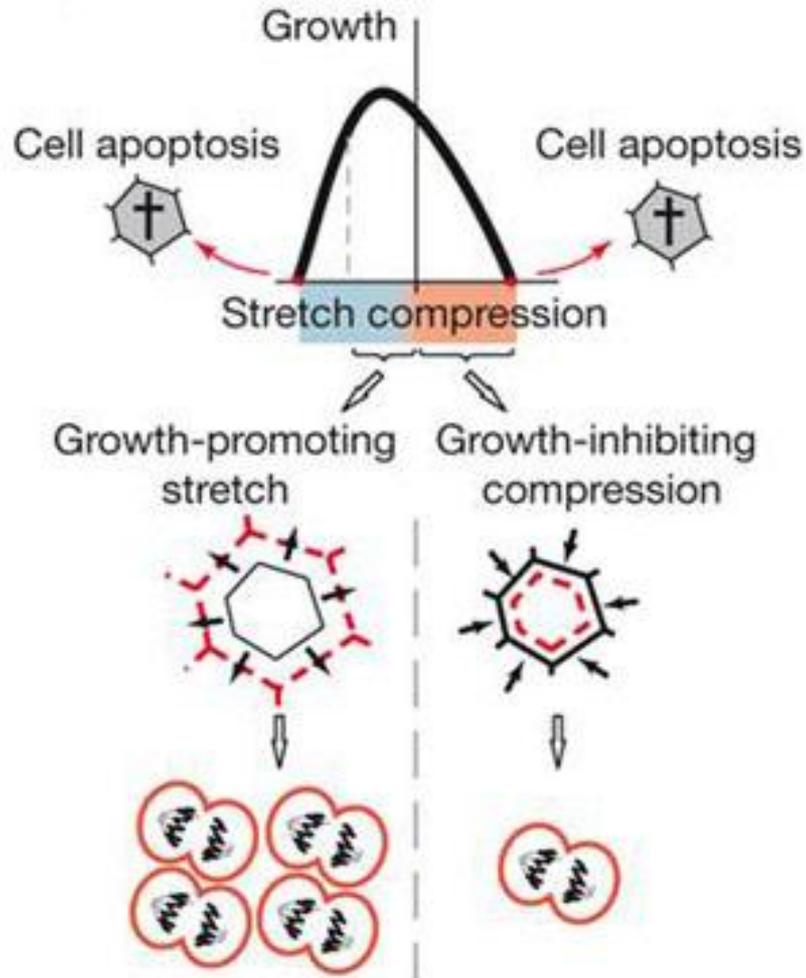


Натяжение предотвращает апоптоз



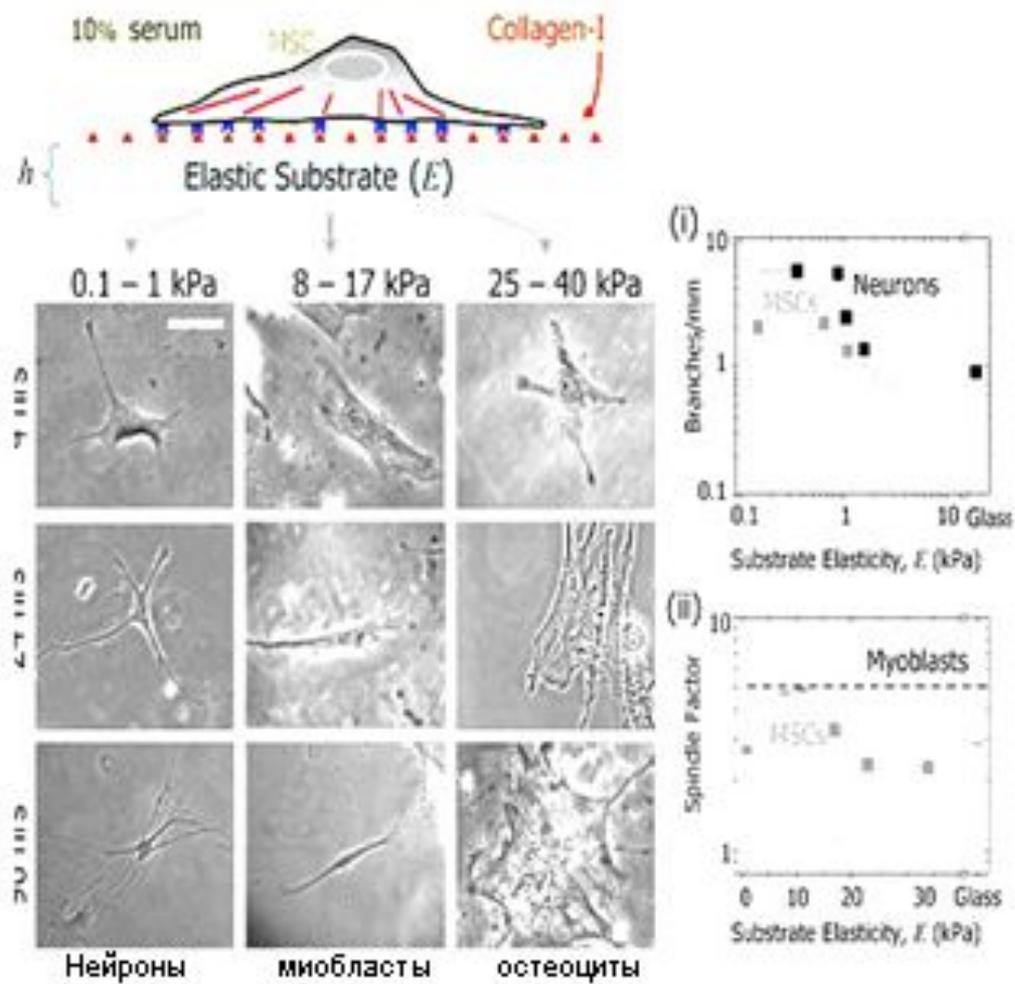
ВЫБОР ПУТИ ДИФФЕРЕНЦИРОВКИ ЗАВИСИТ ОТ СТЕПЕНИ РАСПЛАСТАННОСТИ КЛЕТКИ (R. McBeath et al. (2004) *Developmental Cell* 6: 483-495.

РАСТЯЖЕНИЕ СПОСОБСТВУЕТ РОСТУ, СЖАТИЕ ПОДАВЛЯЕТ РОСТ
ЧРЕЗМЕРНЫЕ НАПРЯЖЕНИЯ ВЕДУТ К АПОПТОЗУ

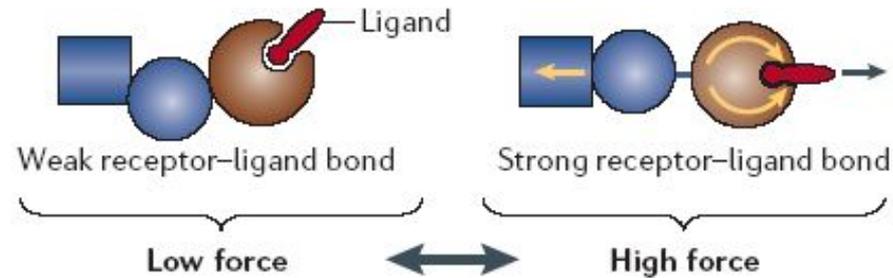
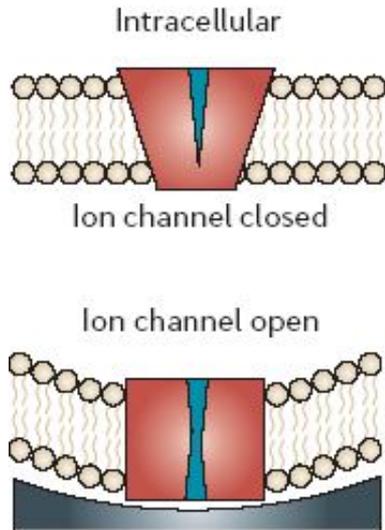


МЕХАНИЧЕСКИЕ СВОЙСТВА СУБСТРАТА МОГУТ ДЕТЕРМИНИРОВАТЬ ПУТИ ДИФФЕРЕНЦИРОВКИ СТЕЛОВЫХ КЛЕТОК

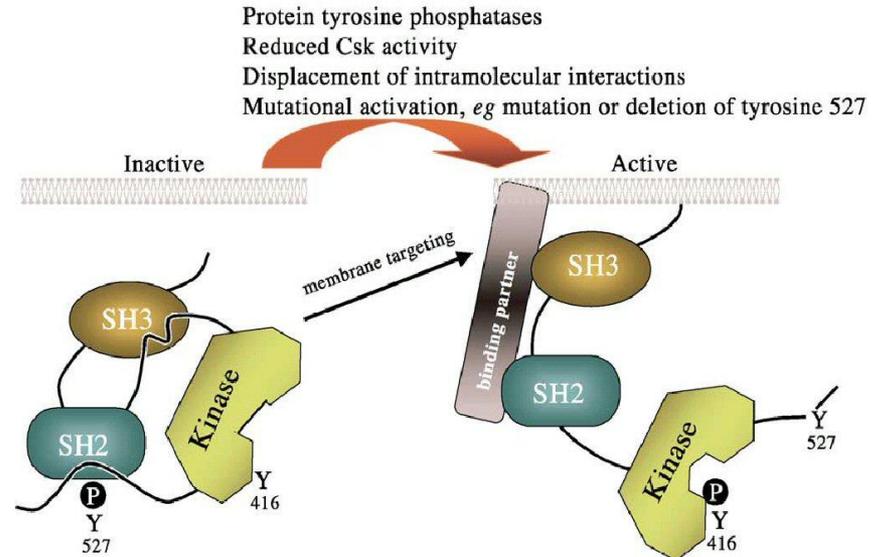
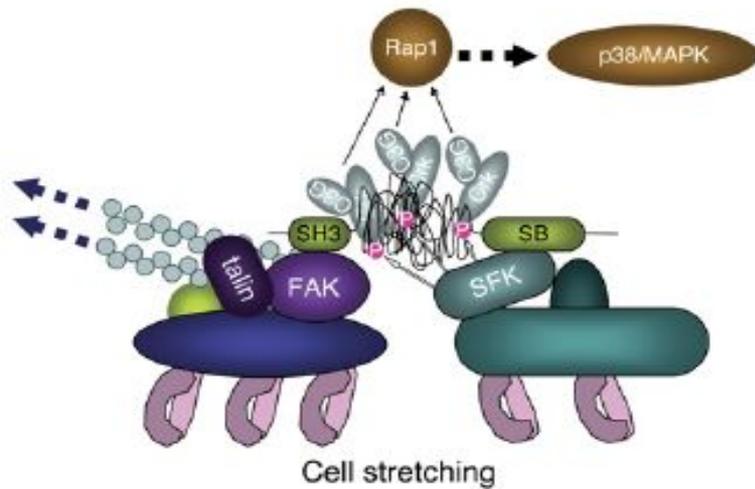
(Engler et al., Cell 126, 677-689 (2006))



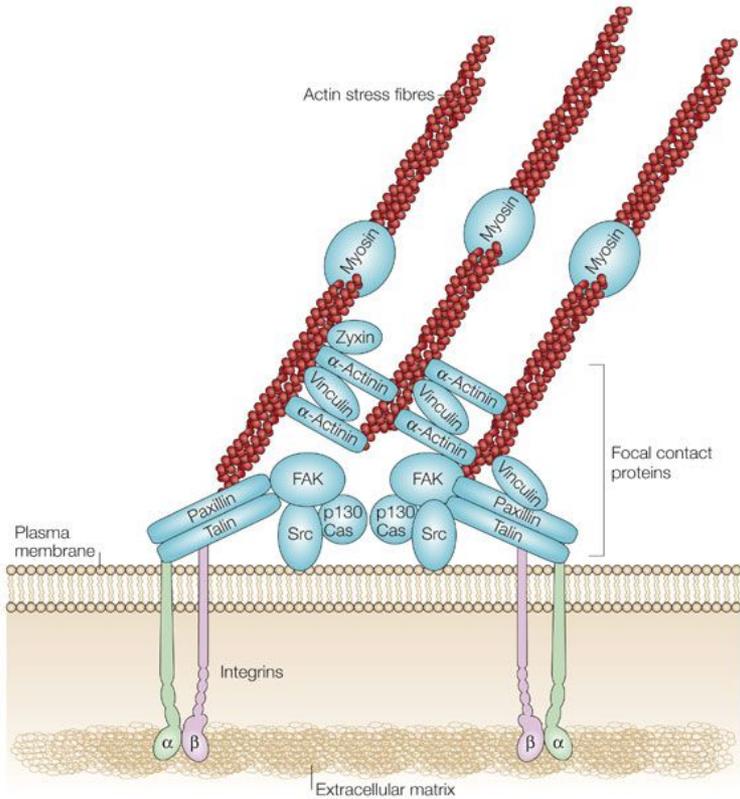
РЕЦЕПТОРЫ МЕХАНИЧЕСКИХ НАПРЯЖЕНИЙ



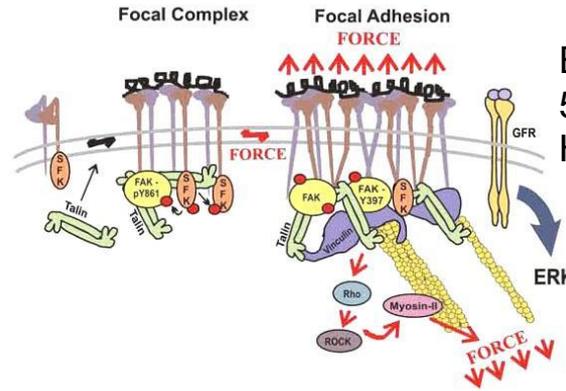
РАСТЯЖЕНИЕ CAS СПОСОБСТВУЕТ ЕГО ФОСФОРИЛИРОВАНИЮ



ФОКАЛЬНЫЕ КОНТАКТЫ: МЕХАНОЗАВИСИМАЯ СБОРКА, ОБРАТНЫЕ СВЯЗИ С ВНУТРИКЛЕТОЧНЫМИ СОКРАТИТЕЛЬНЫМИ МЕХАНИЗМАМИ



Nature Reviews | Molecular Cell Biology



Базовые напряжения в FA – $5,5 \text{ nN}/\mu\text{m}^2 = 5,5 \times 10^3 \text{ Pa}$.
 На одну молекулу интегрина
 $\sim 3 - 5 \times 10^{-12} \text{ N}$
 (достаточно для растяжения)

Фокальные
контакты

$\text{RhoGTP}^* \leftrightarrow \text{RhoGDP}$

Рост ФК

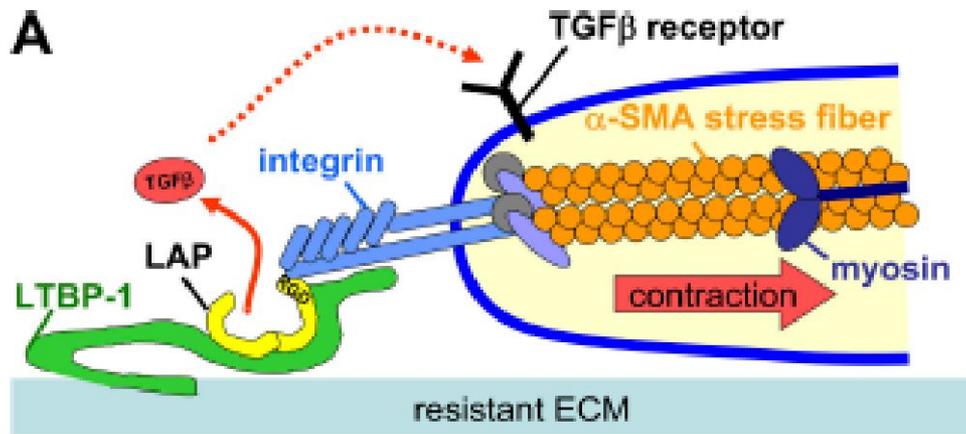
Рho-зависимая
киназа

Киназа легких
цепей миозина

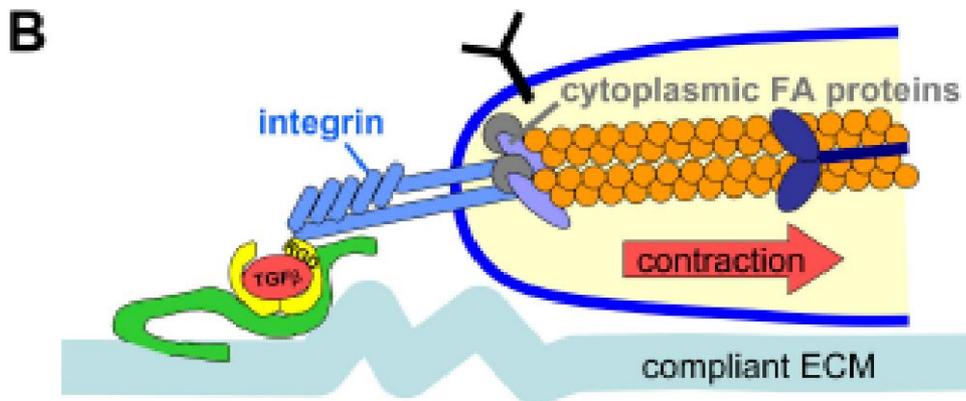
натяжение

COOPERATION OF MECHANICAL FACTORS WITH MATRIX-BOUND CHEMICAL MORPHOGENES

Wipff et al. *The Journal of Cell Biology*, Vol. 179, No. 6, December 17, 2007 1311-1323
<http://www.jcb.org/cgi/doi/10.1083/jcb.200704042>



ECM tension →
Myoblast differentiation



No differentiation

ДИНАМИЧЕСКИЙ БАЛАНС МЕХАНИЧЕСКИХ СИЛ В МЕЖКЛЕТОЧНЫХ КОНТАКТАХ ТИПА ADHERENT JUNCTIONS

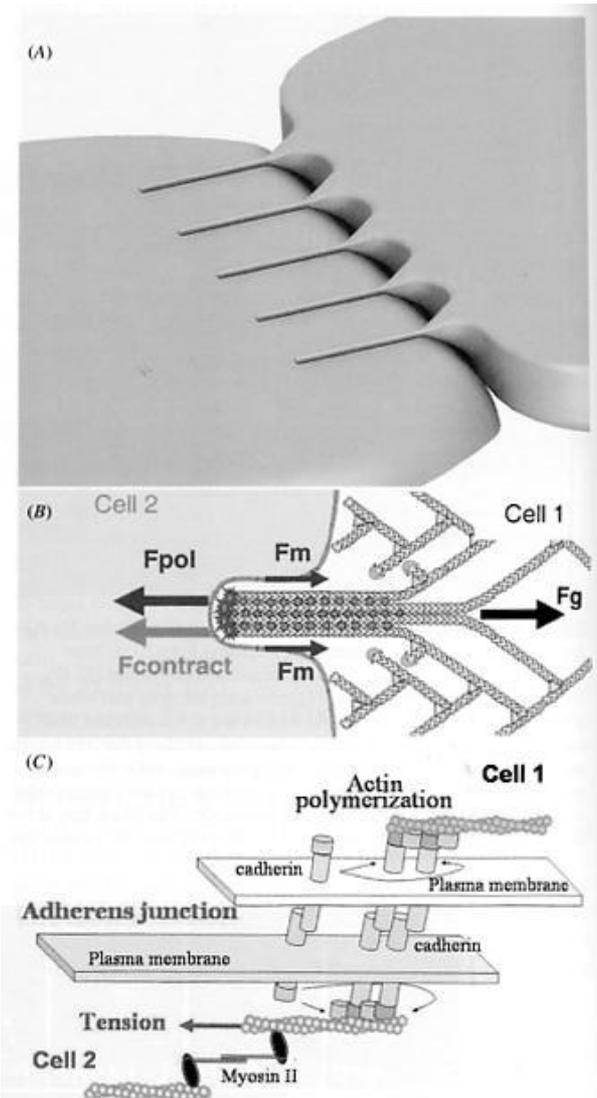
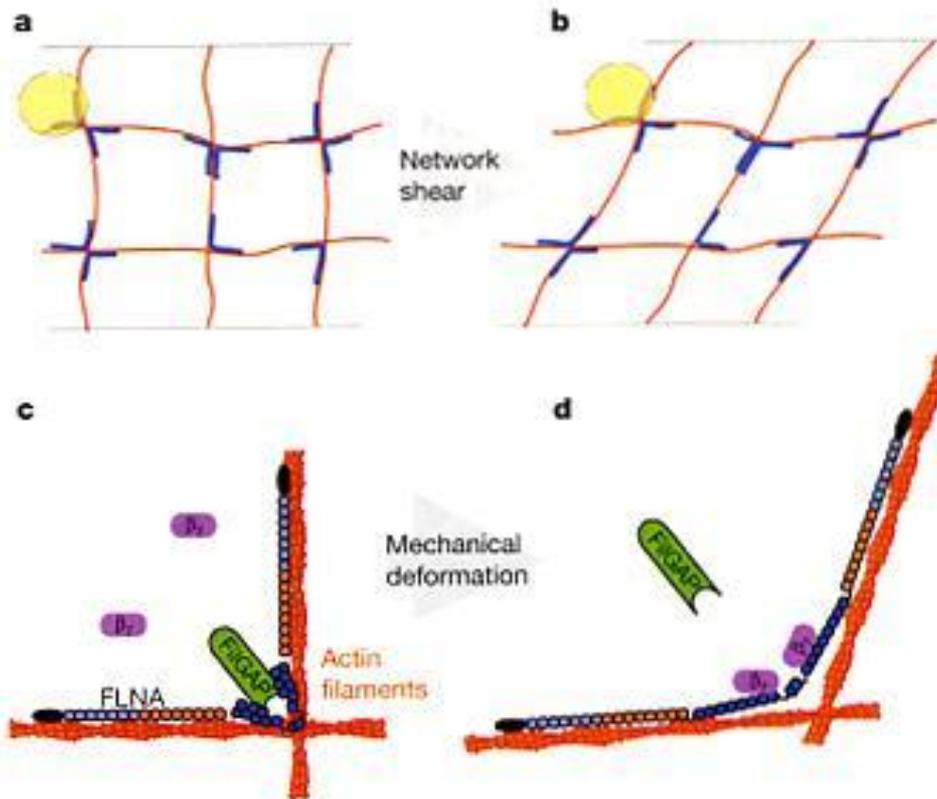


Figure 5. Representation of the AJ finger assembly. (A) 3D view of the donor/acceptor cell scheme. (B) Detailed top view of a single finger projected by Cell 1 onto Cell 2; the actin cytoskeleton is depicted in Cell 1, and the relevant forces are depicted with the subscripts contract, g, m and pol referring to contractility, gel, membrane and polymerization respectively. (C) A molecular model of the adherens junction, showing the different connecting units as grey and pink cylinders in contact with the cytoskeletal structures of both the donor and acceptor cell.

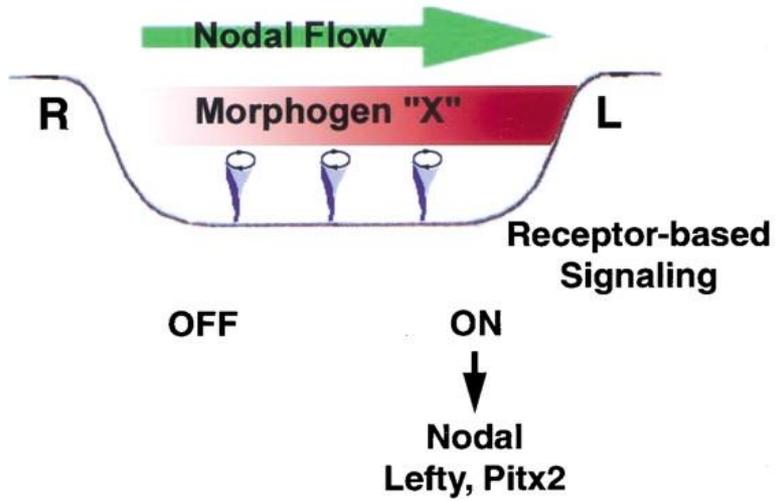
Филамин как центральный механотрансдуктор цитоскелета



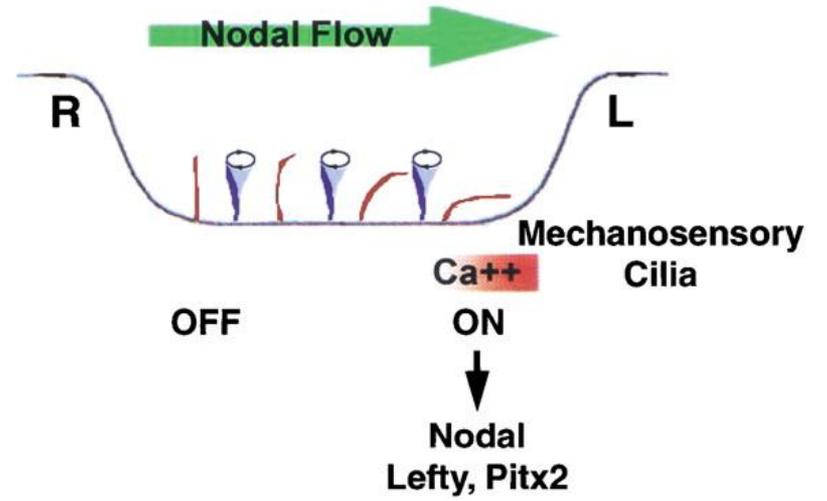
При деформации актинового геля как внешней силой, так и миозином II, филамин утрачивает сродство к FilGAP (GTP-ase associating protein specific for RAC – регулирует распластывание клеток и блеббинг) и повышает сродство к β -интегринам (Nature 2011)

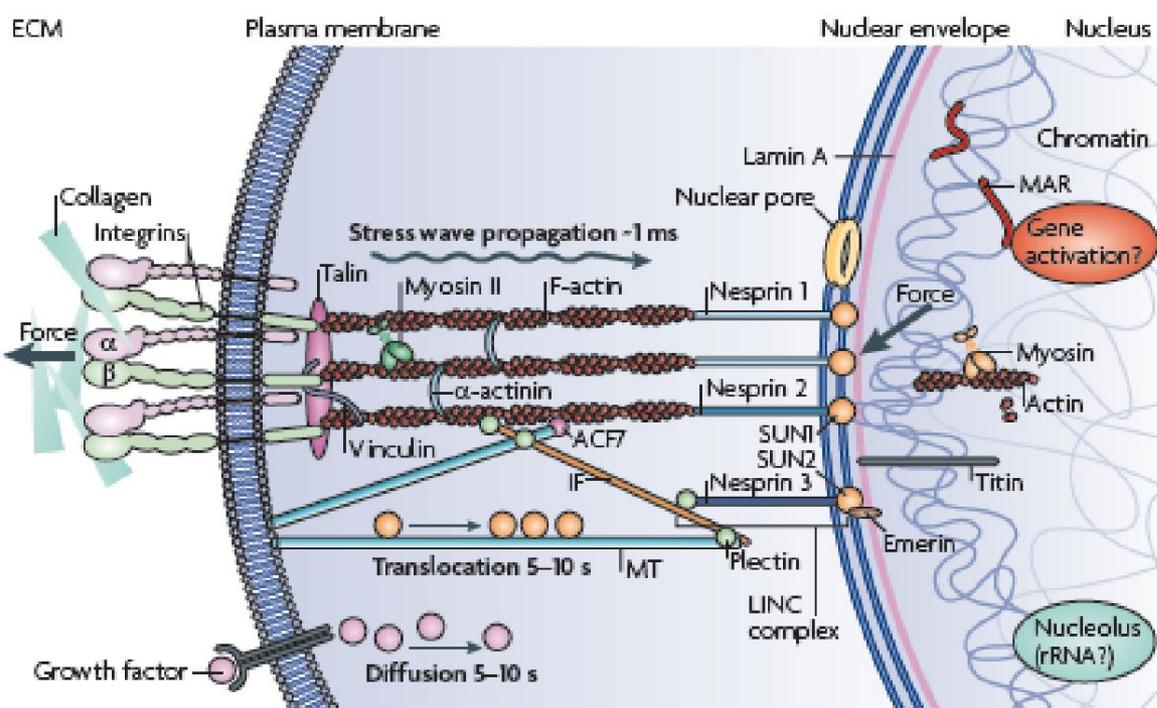
Механозависимые реснички

A

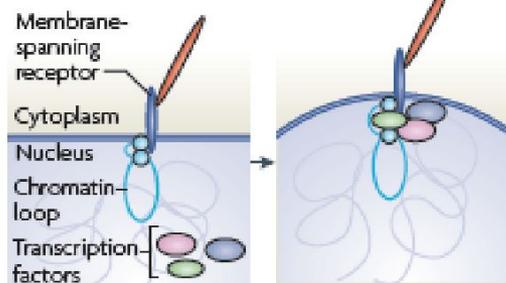


B

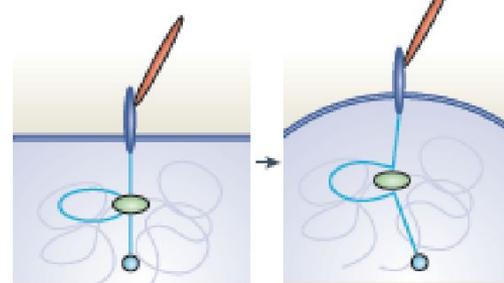




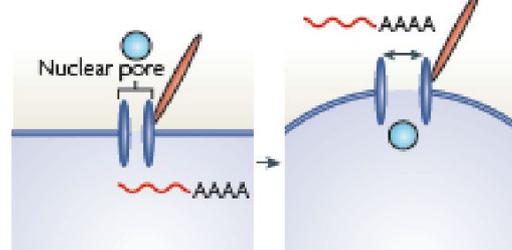
a Chromatin recombination



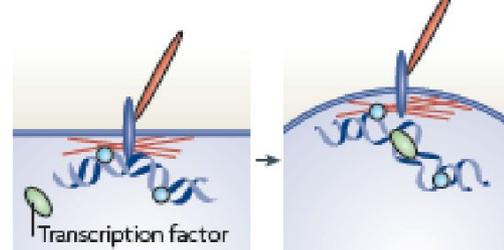
b Nuclear matrix distortion

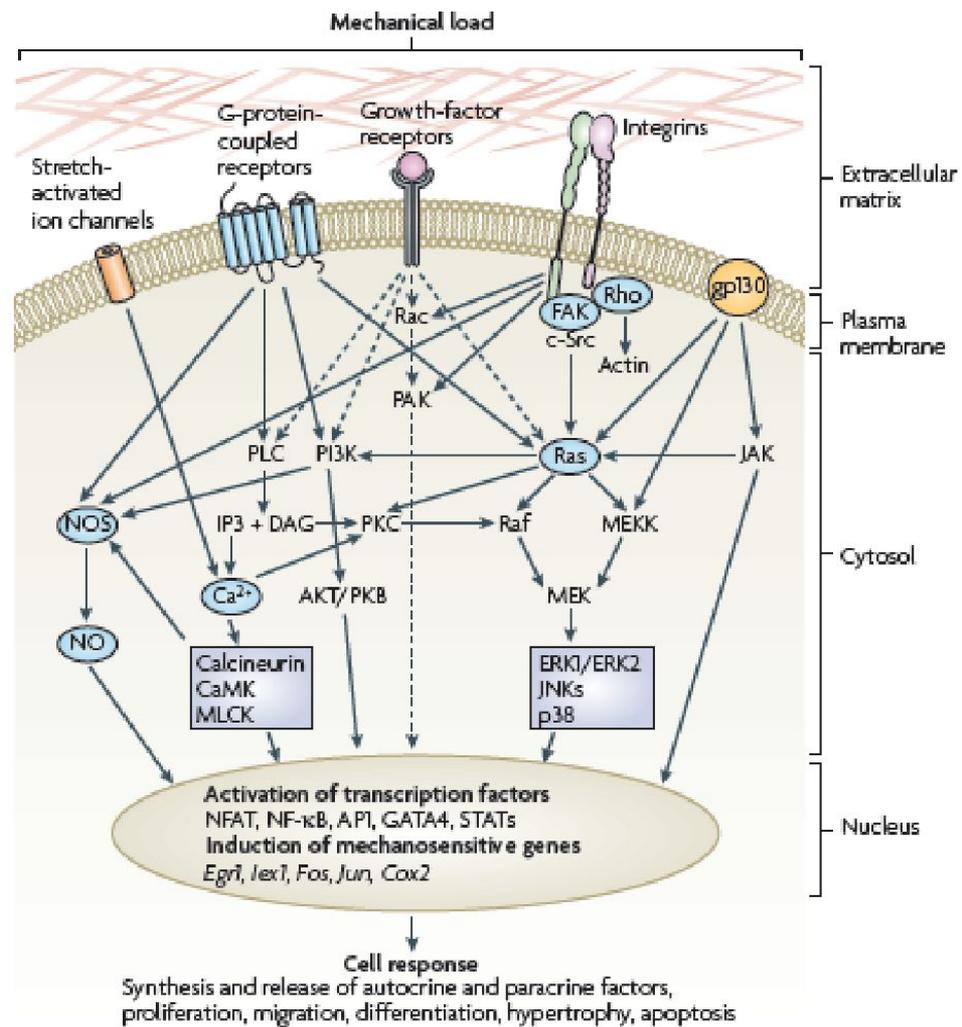
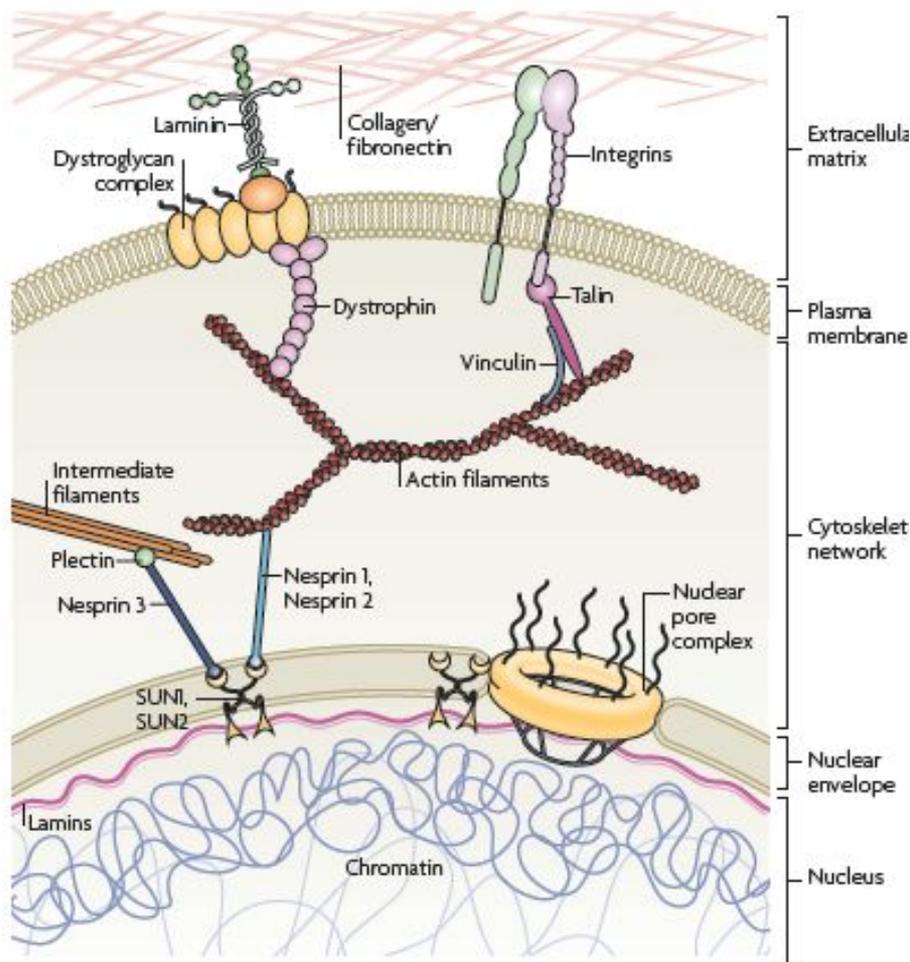


c Nuclear transport



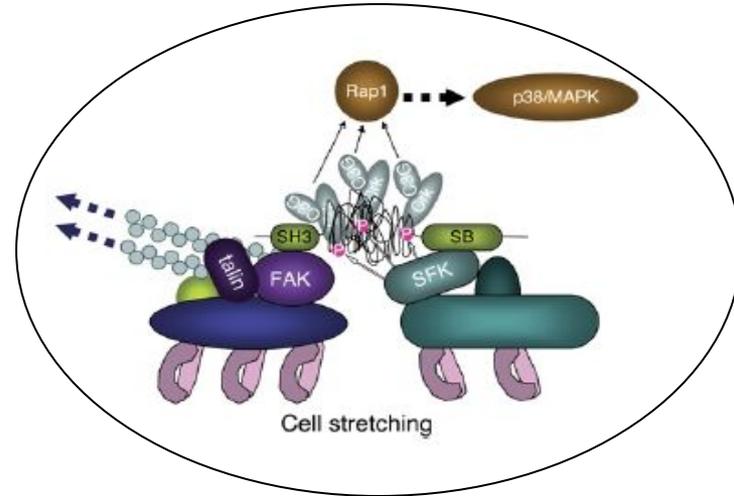
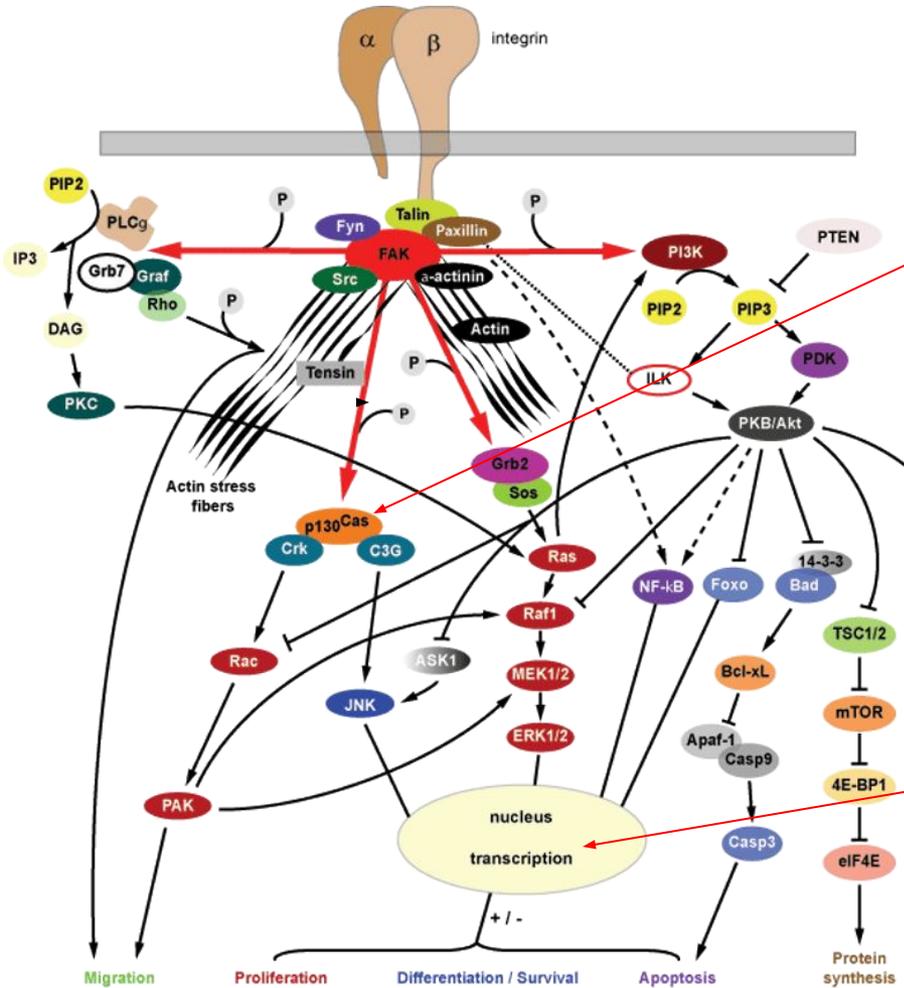
d DNA melting



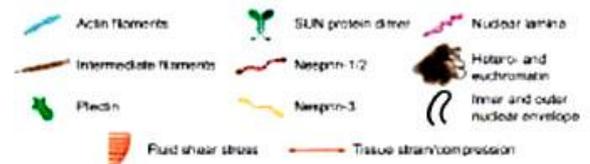
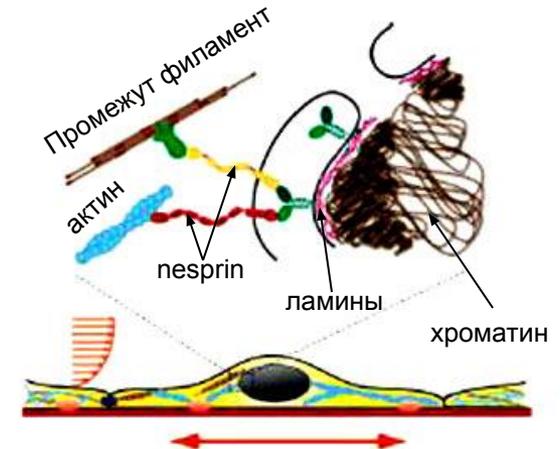


СИГНАЛЬНЫЕ ПУТИ, ИДУЩИЕ ОТ ФОКАЛЬНЫХ КОНТАКТОВ

МЕХАНИЧЕСКОЕ РАСТЯЖЕНИЕ УСИЛИВАЕТ ТИРОЗИН-ФОСФОРИЛИРОВАНИЕ p130 CAS



МЕХАНИЧЕСКИЕ СИГНАЛЫ В ЯДРО



ОБРАТНЫЕ СВЯЗИ С УЧАСТИЕМ Rho-БЕЛКОВ И МЕХАНИЧЕСКИХ НАПРЯЖЕНИЙ

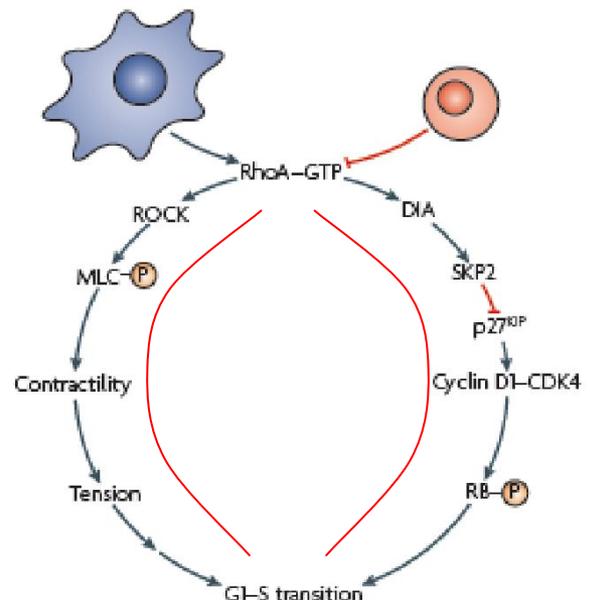
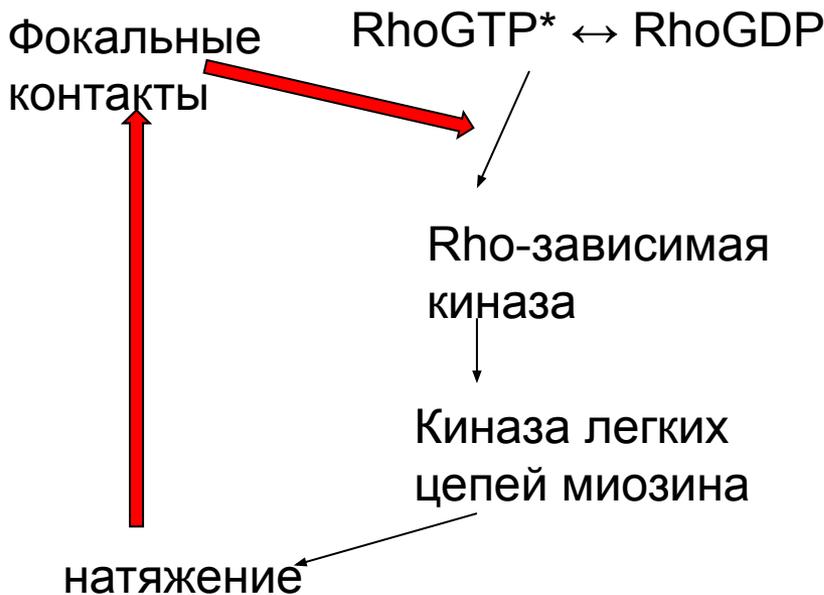


Figure 2 | Cell shape regulates proliferation through the small GTPase RhoA. Restricting cell spreading decreases proliferation through the regulation of RhoA activity. RhoA promotes G1-S-phase transition and cell proliferation through two pathways. First, the RhoA effector, Rho kinase (ROCK), increases myosin light chain (MLC; also known as MYL) phosphorylation to generate cellular contractility. This generates the tension in the cell that is required for proliferation^{57,58}. Second, the RhoA effector, diaphanous (DIA), activates the ubiquitin ligase SKP2 to inhibit the cyclin-dependent kinase (CDK) p27^{KIP} (also known as CDKN1B). p27^{KIP} can no longer degrade the cyclin D1-CDK4 complex, so this complex phosphorylates retinoblastoma protein (RB), thereby leading to the G1-S-phase transition^{55,56}. Restricting cell shape decreases RhoA activity in some cell types, so these two pathways are not activated. Without contractility and tension generation as well as SKP2 activity, G1-S-phase transition is blocked and proliferation is reduced.