제 5 강.

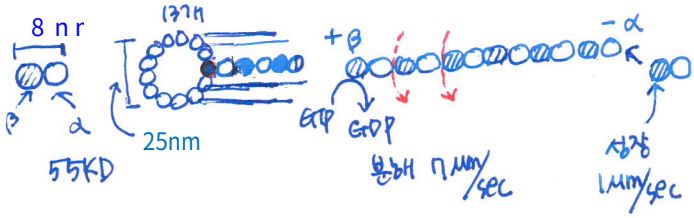
Actin & Myelin

제9회 특별한 뇌과학

2017. 10. 22

· 신경세포를 배운다

1. Actin filament 36nm, 14. 375 aa. 42KD.



microtubule

8, 13. 25. 55. 1. 7

55kd → 성장속도 1um/sec

분해속도 nm/sec

2. myelin 수초

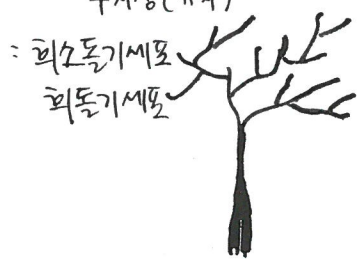
Schwann cell : 말초

oligodendrocyte : 중추

수지상(가지)

: 희소돌기세포

희돌기세포

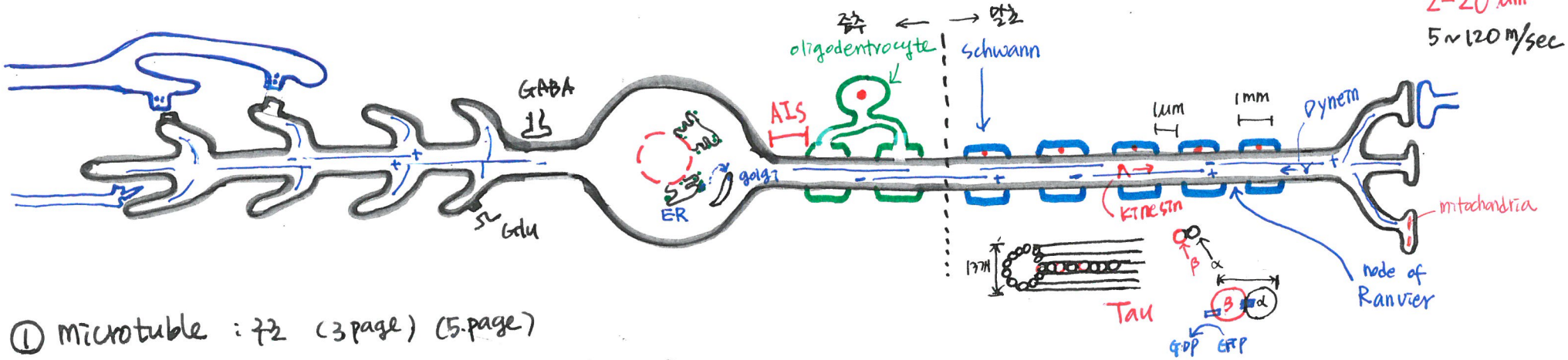


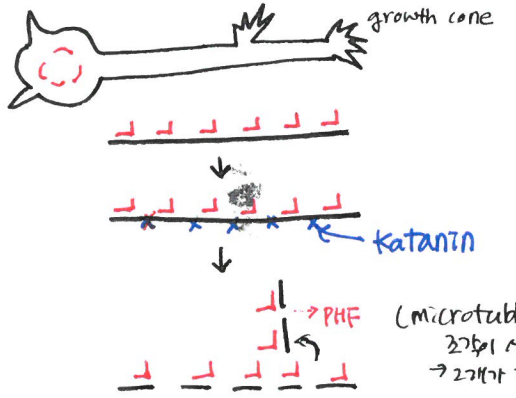
* microglia

astrocyte 성상세포 → 오세철광.

시냅스 모든 장제에 관여

SER - ribosome o
RER - " x





① Microtuble : 구조 (3page) (5.page)

② 세포 핵막. (S)ER, Golgi - 단백질 생성 (4page)

③ actin : 어느 곳에나 있다 (5page) - ATP와 결합

④ microtubule : 방향성 (6page) axon part

⑤ actin cycle (7page)

⑥ F-actin (8page)

⑦ actin filament control pathway (9page)

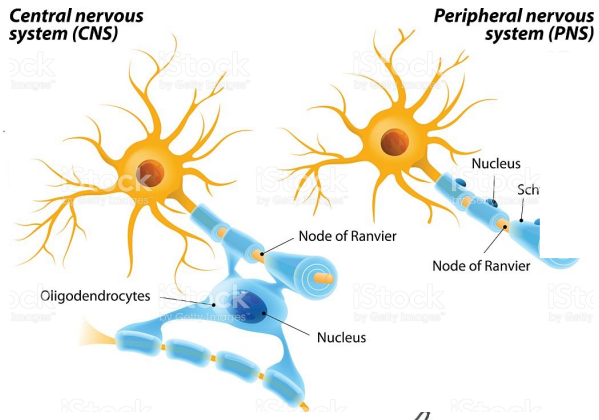
⑧ axon의 AIS, 상피에 결절의 ion 채널 (11page)

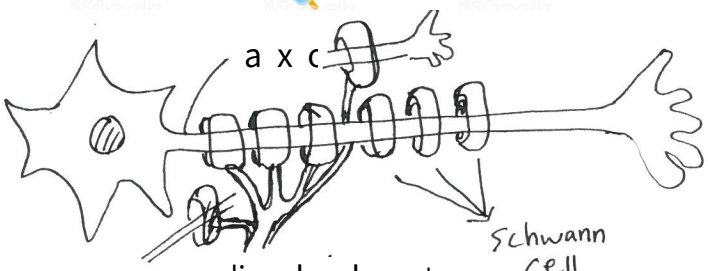
⑨ astrocyte & Glu-Gln-GABA (12page)

⑩ myelination (13,14page)

⑪ 단백질(아미노산), 해산 방향 (15page)

(2017.10.22. 특뇌9회 5강 박문호박사님 강의 녹취 노트)





oligodendrocyte

(여러 세포에 걸쳐) Schwann cell (1개씩)

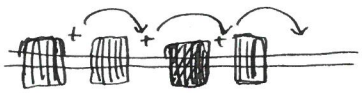
→ 넓게 퍼진다

절연 tape 역할을 해서

axon에 흐르는

전기전달을 돕는다.

1000개의 세포가 공재한다



stress를 받으면

강성한 Schwann cell이

풀어진다

(= 루게릭병)

바다의 무척추 동물 2종은

Schwann이 없다.

⇒ 오징어 축색 500μm

노벨상 연구시 활용됨

1mm 1000개 까지 가능

=1m

생물학은 3분자 이야기

ATP ← actin

GTP ← tubulin

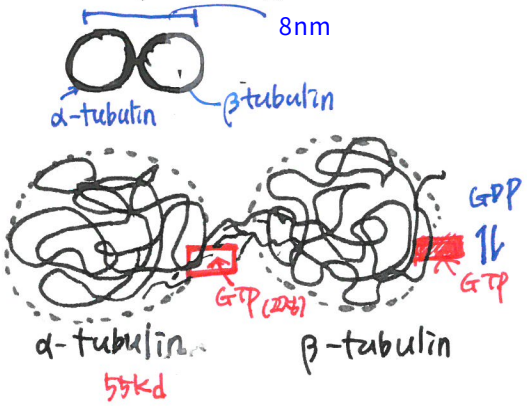
Pi

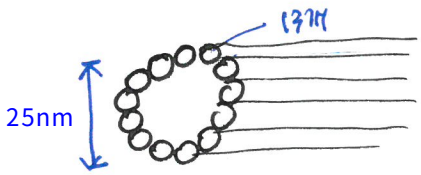
T & D 이야기

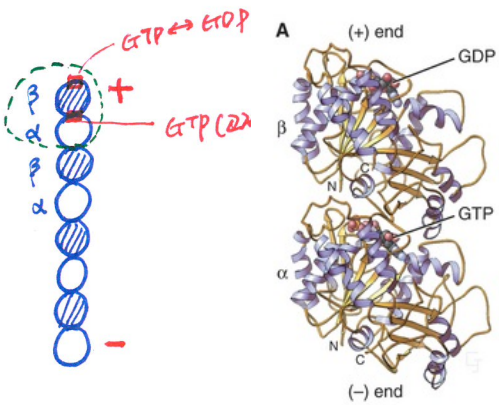
ATP ⇌ ADP

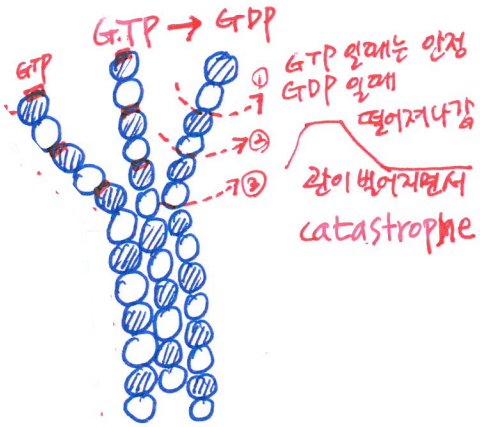
GTP ⇌ GDP

[microtubule 구성단위]

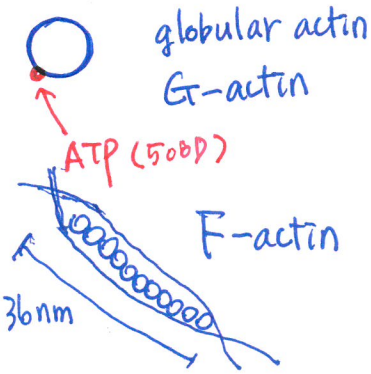








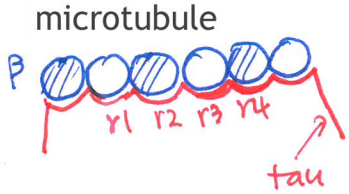
cf Actin



375 aas

42 KD

microtubule



성장하면서

100개/sec

1μm/sec

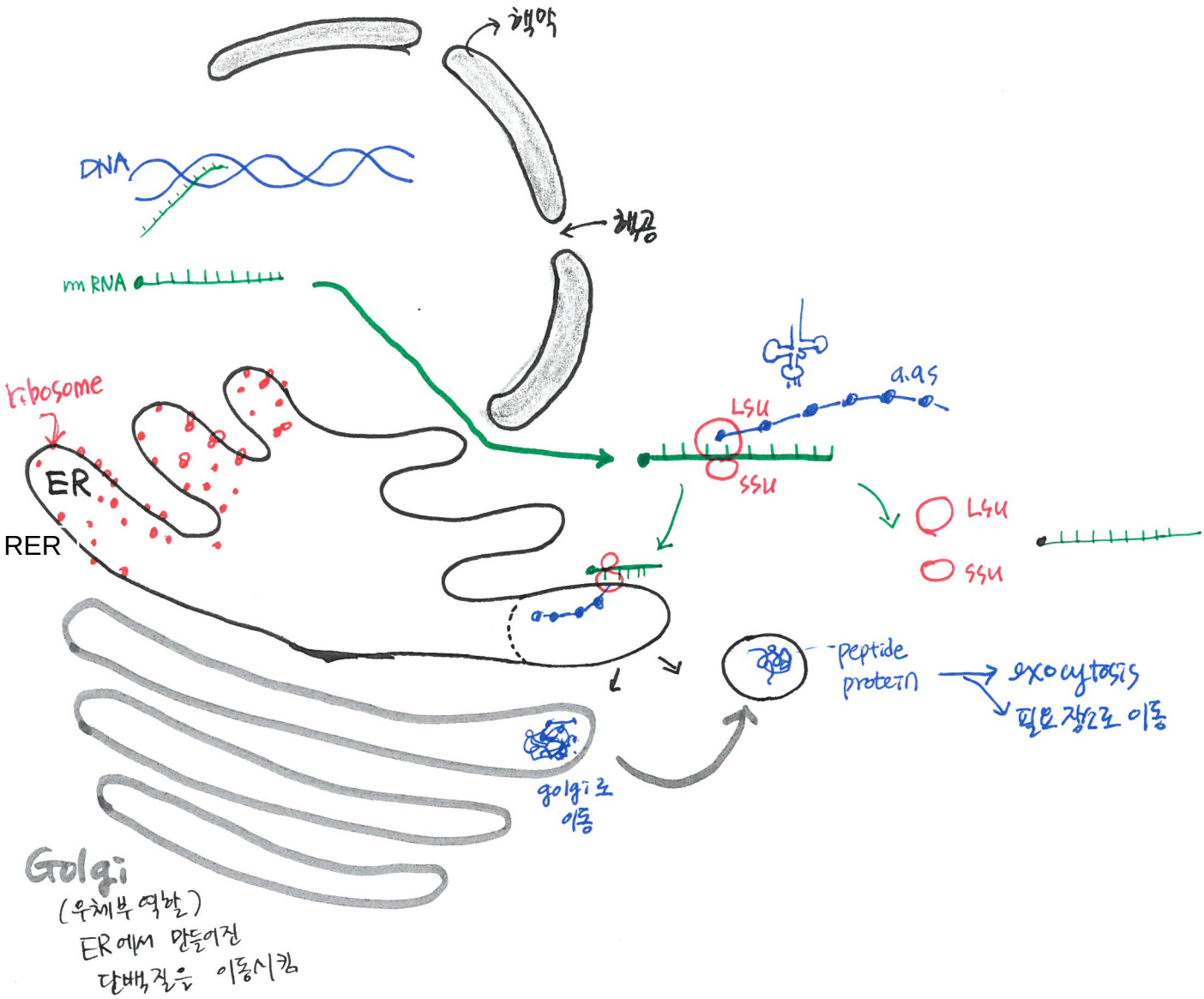
분해된다

7μm/sec

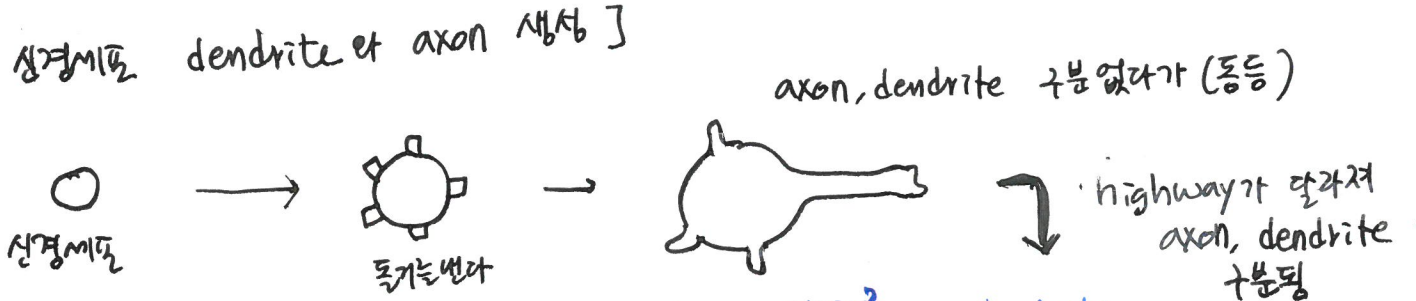
100~1000개/sec

(하버드 동영상 참조할 것)

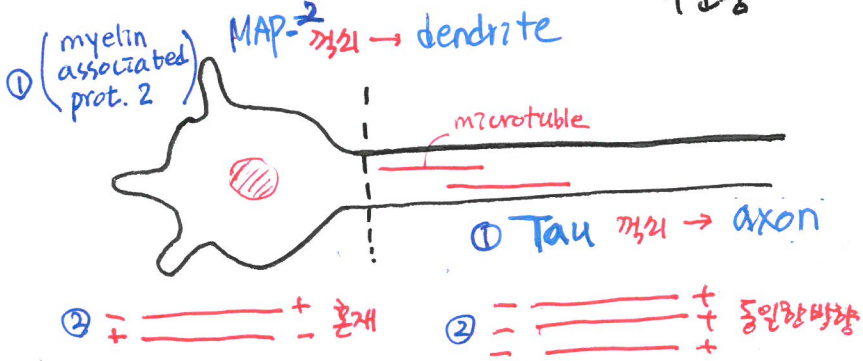
The Inner Life of the Cell
https://www.youtube.com/watch?v=FzcTgrxMzZk

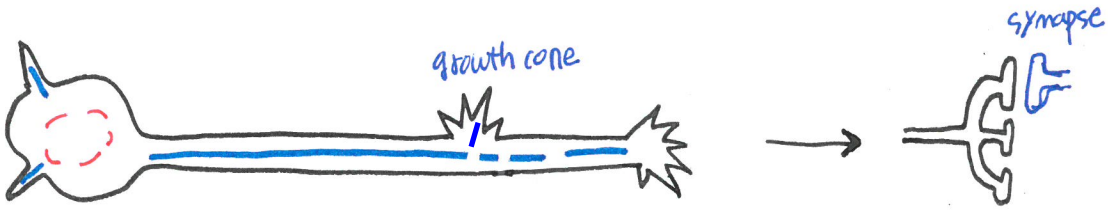


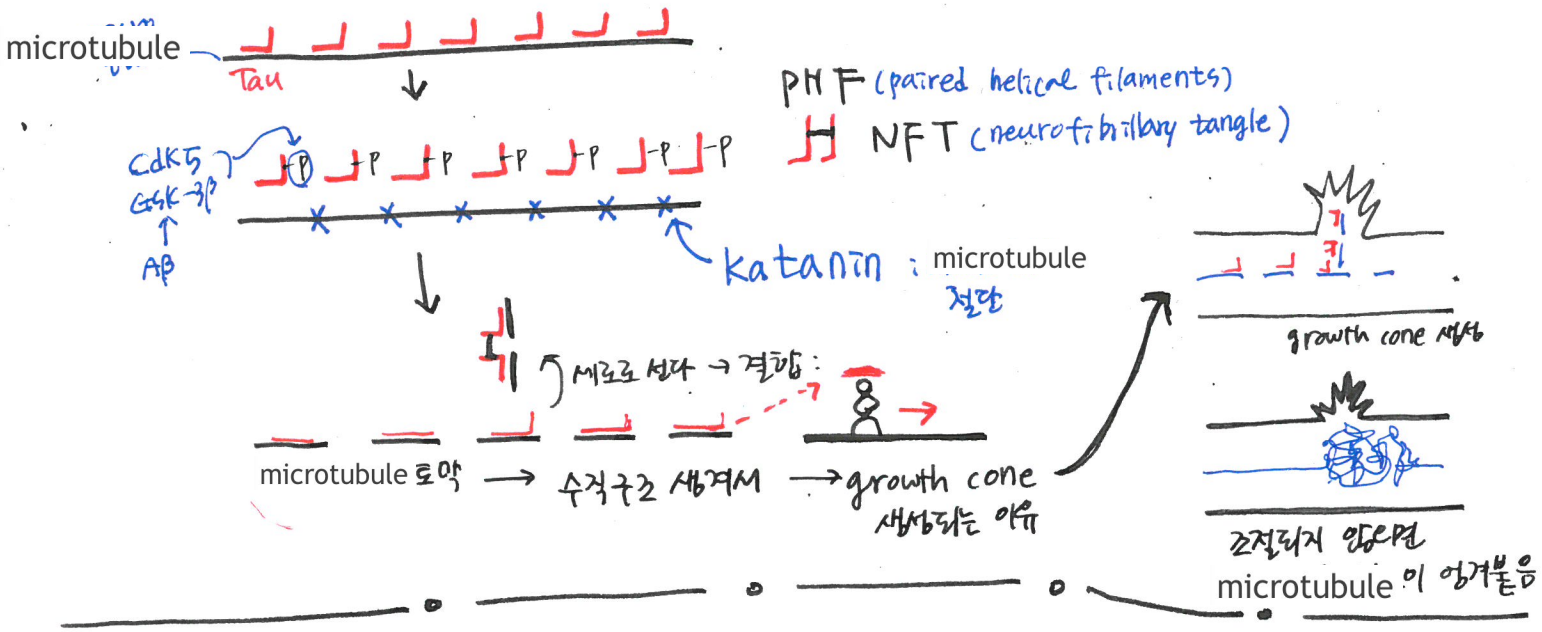
[신경세포 dendrite와 axon 생성]



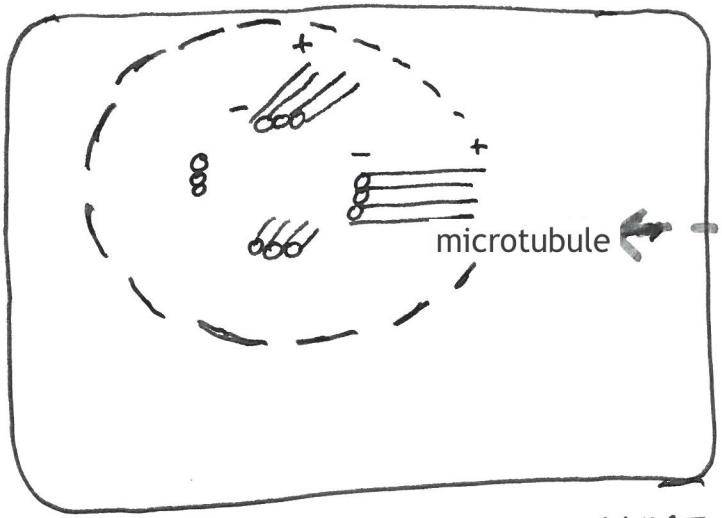
dendrite ↔ axon		
꺾리	MAP-2	Tau
microtuble 방향	혼재	동일





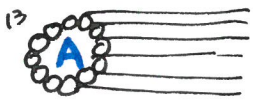


● pericentriolar material : 미세소관 만드는 원물질 (센터)

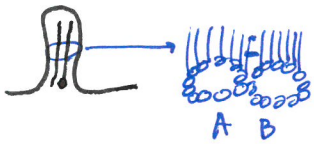


[미세소관 3 type]

① singlet : A only (13개)

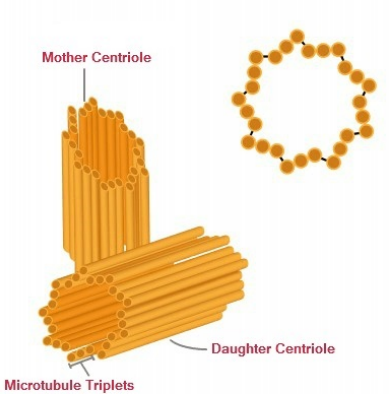


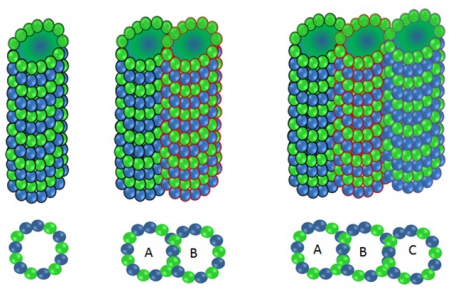
② doublet
: 소장벽 (microvilli), 편모

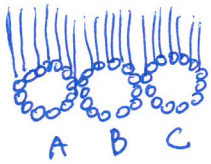


③ triplet
: 중심체. basal body

microtubule organizing center : MTOC



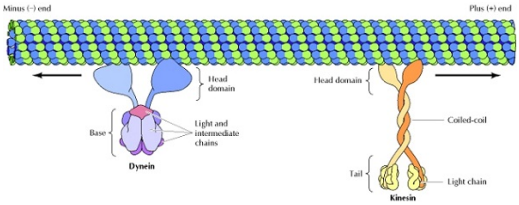


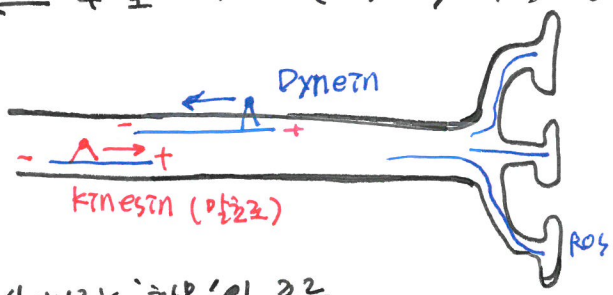


[axon part] '방향' 있는 도로에는 '자동차'가 있다

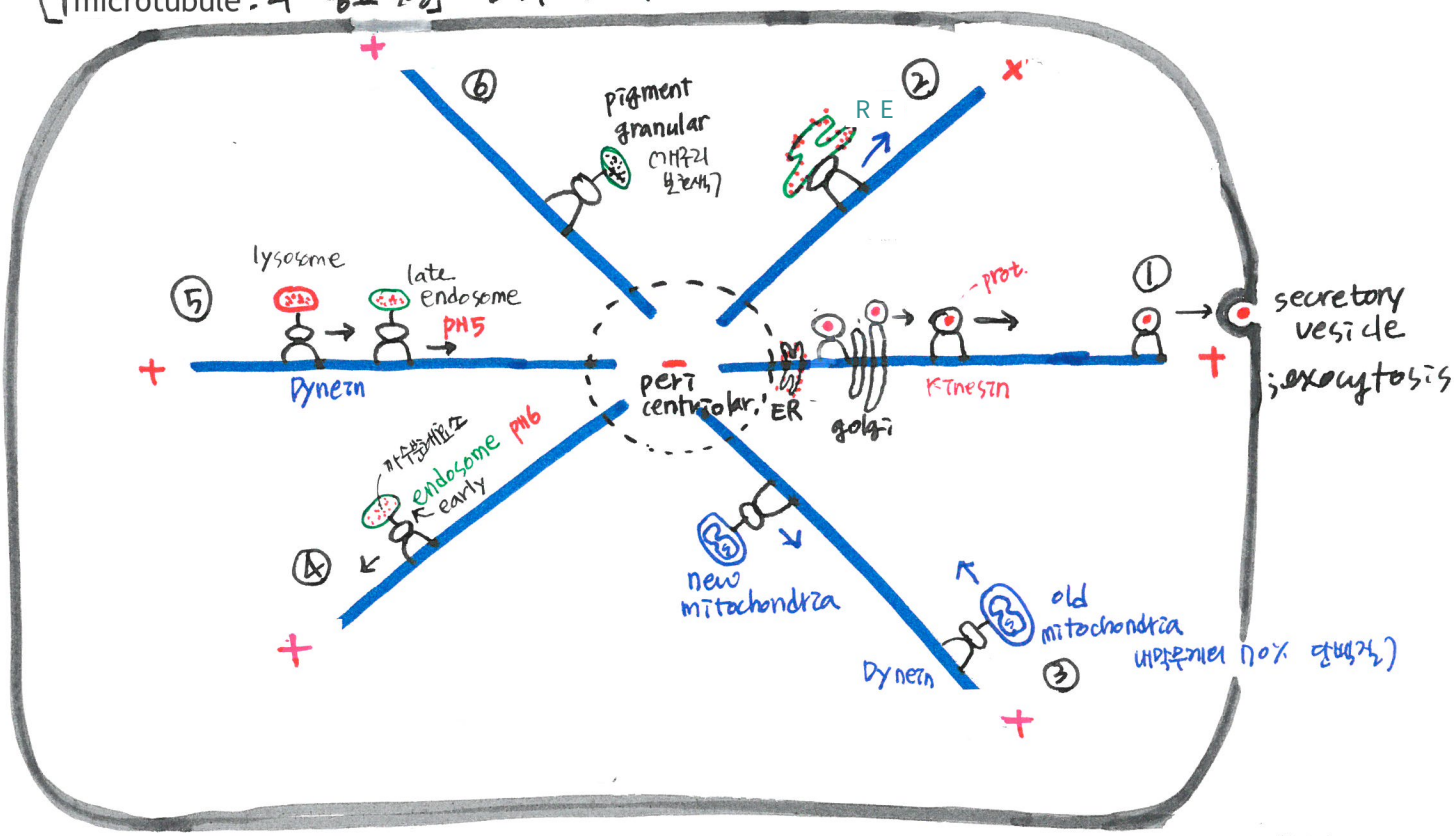
- Kinesin : − → + 로 가는 방향 (말초방향)
- Dynein : − ← + 로 〃 (핵 〃) 폐기물처리용

cf. dendrite 쪽은 방향성이 혼재됨 ⇒ Intermediate filament ⇒ 자동차(motor) X

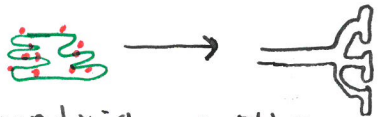




[microtubule의 중요역할] 실어나르는 '화물'의 종류



① RER 에서 만들어진 단백질 → golgi → ⊙ vesicle → 세포밖으로 분비

② RER  말단에서 직접 단백질을 만든다.

③ mitochondria : 말초의 old는 폐기, 새로 만들어진 new는 말초로 전달
by Dynein / by Kinesin
→ 손상 깨지면 axon에 덩어리(혹)이 생긴다 varicosity

④ early endosome : 가수분해효소 함유

⑤ lysosome, late endosome : 〃 → 단백질 분해작용

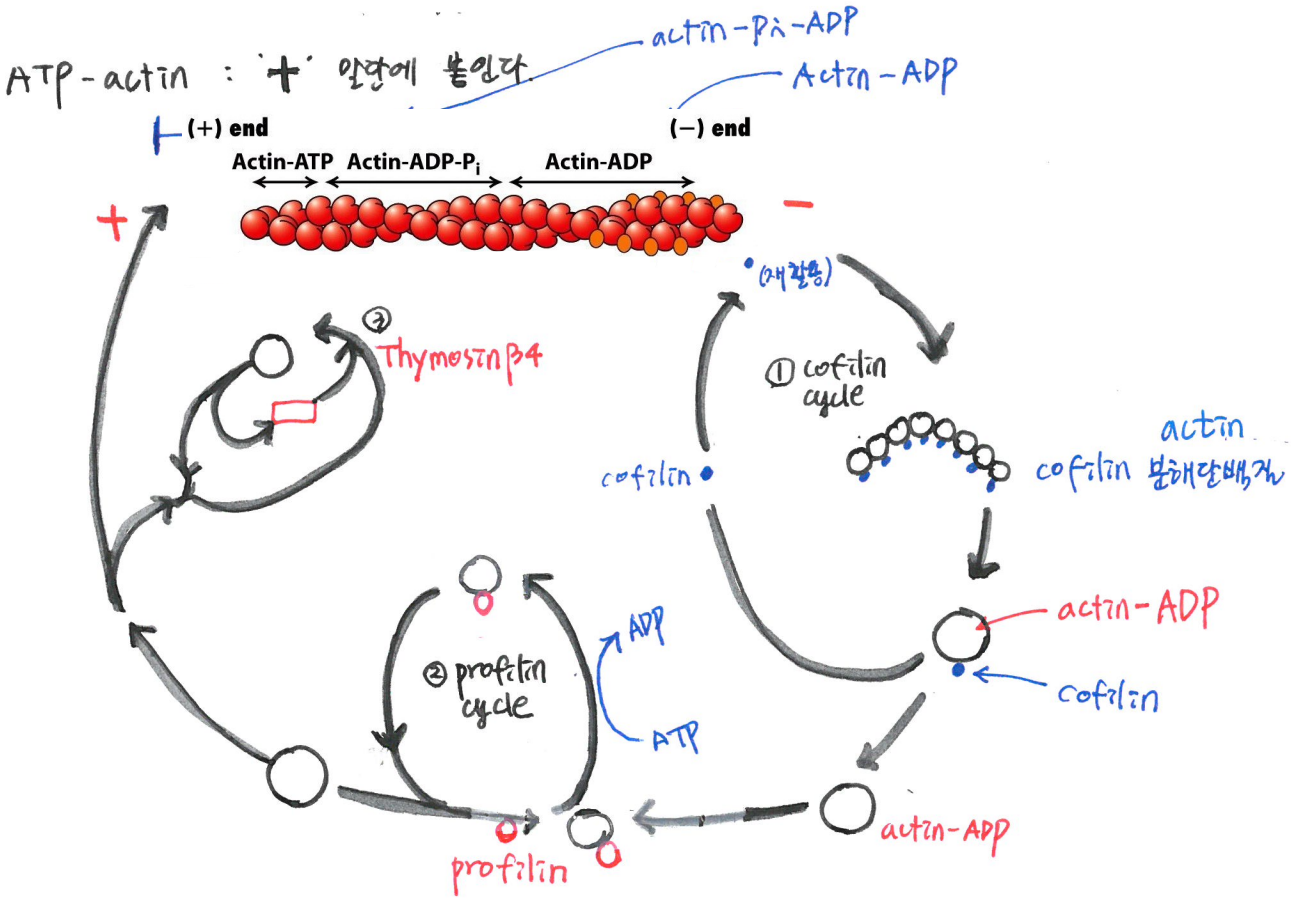
⑥ pigment granule : 개구리 보호색 같은 '색소'를 포함

[actin cycle]

극성이 있으면 "motor"가 있다 ⟶ 결합 / 분해

myosin : actin filament를 수행하는 motor 분자. 유일한 분자이다

ATP-actin : '+' 말단에 붙인다.



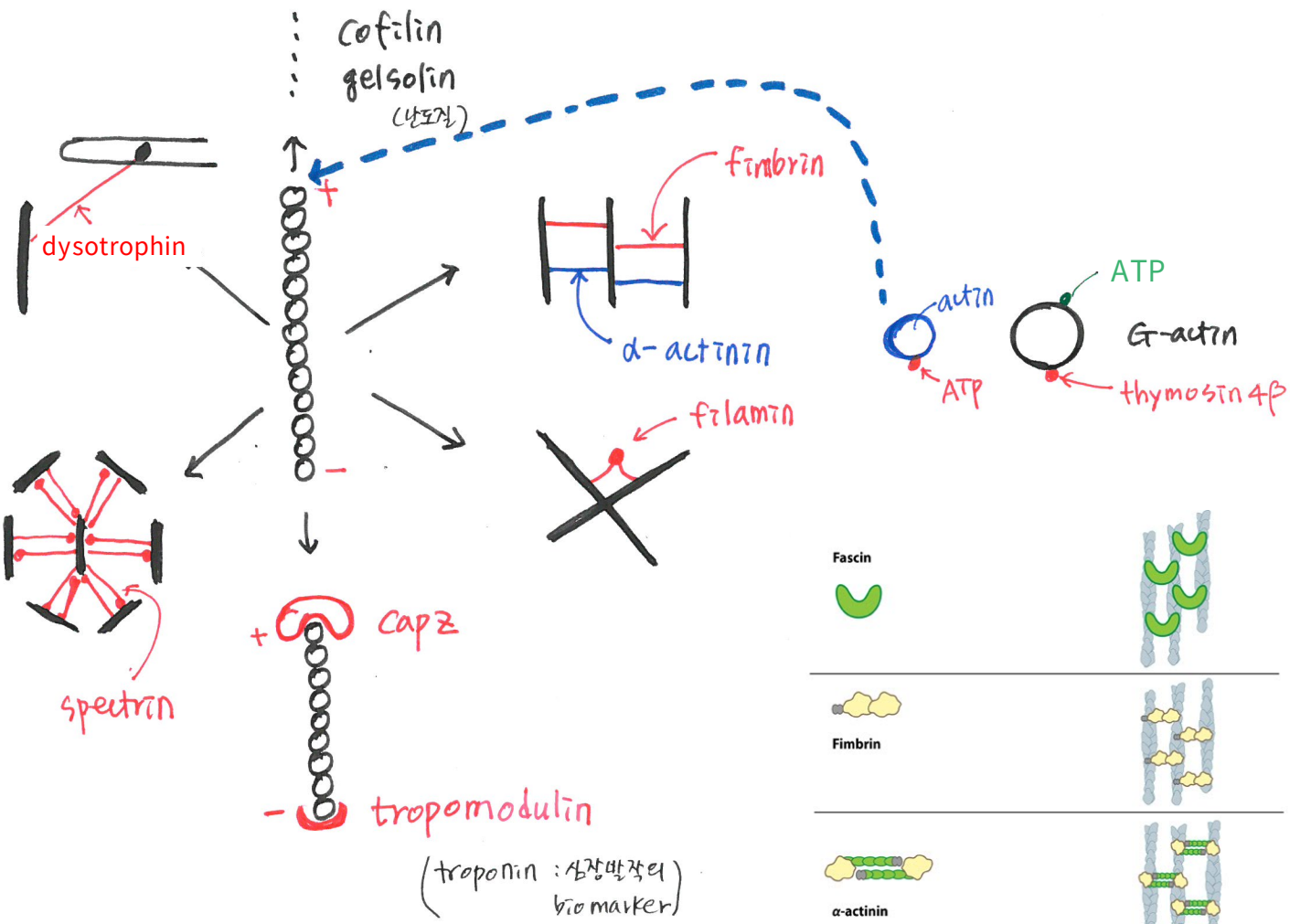
microtubule의 길이를 조절하는 것이 관건이다.

제한없이 계속 성장하게 되면 ⟶ "암"

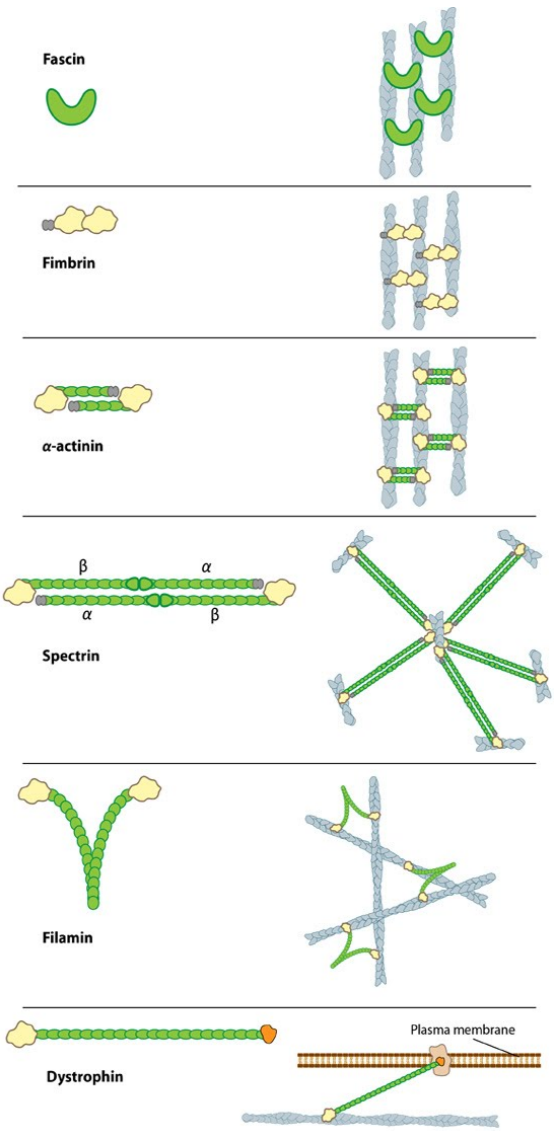
많은 단백질과의 상호작용을 통해 '길이'의 왕급을 조절한다.

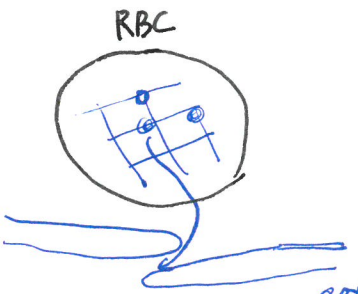
① cofilin cycle •
② profilin cycle ○
③ thymosin β4 cycle ▭

[G-actin ↔ F-actin]



(troponin : 심장박작터
bio marker)

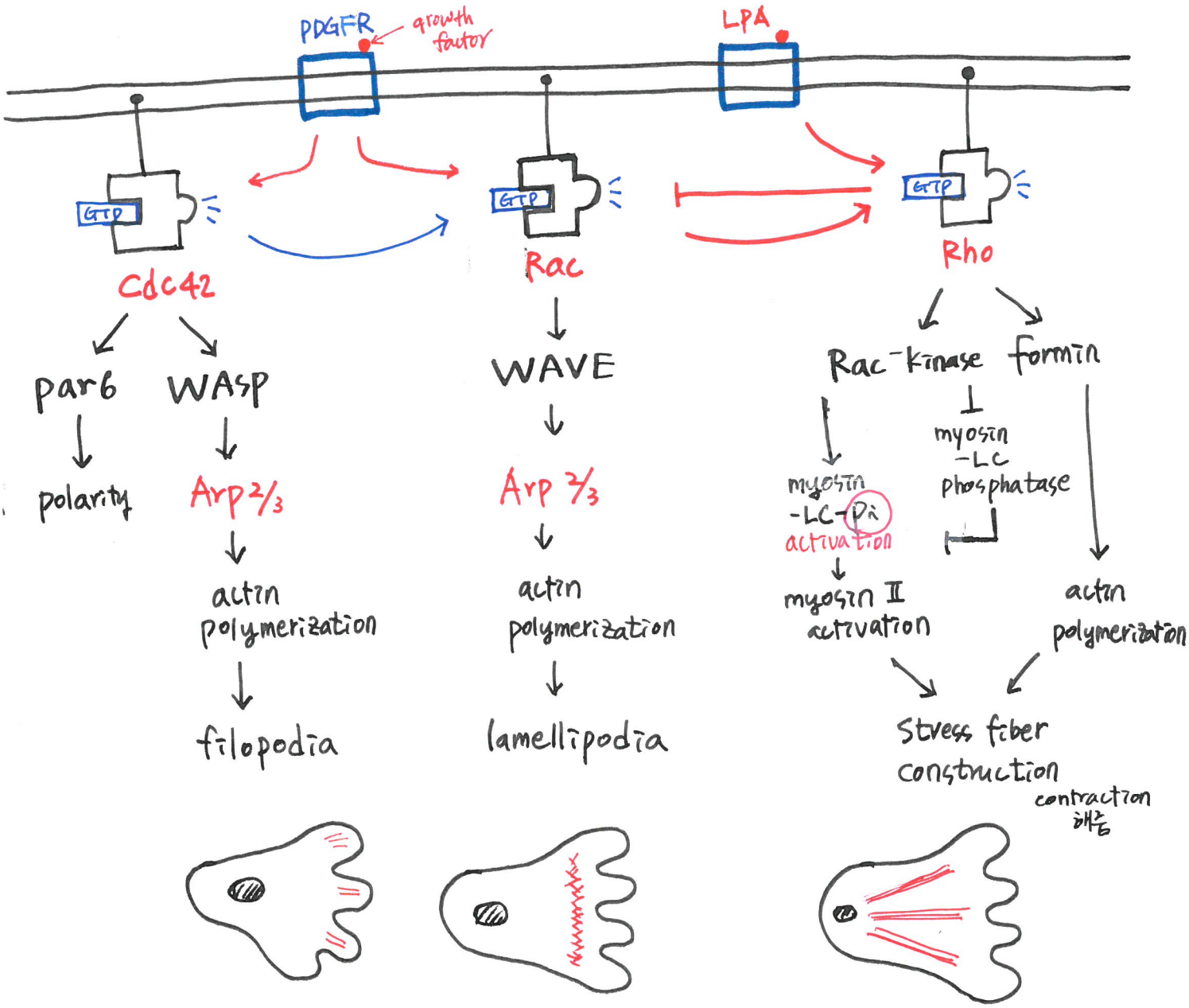




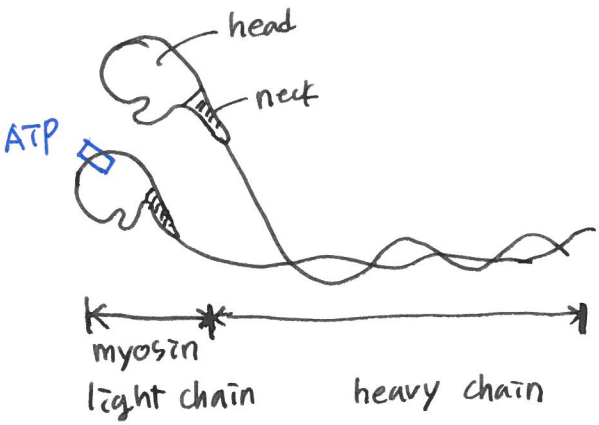
혈세포막
유연성을 제공하는 것
Spectrin (움직일 수 있게
가능하게 한다)

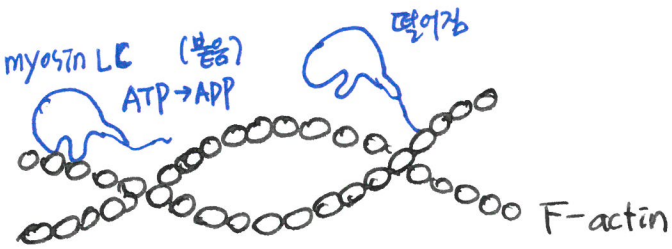
[actin filament control pathway 3]

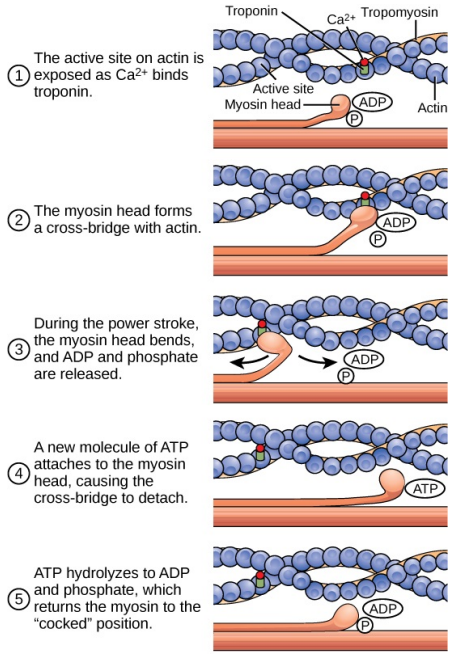
↳ 세포 내 모든 곳에 존재한다.

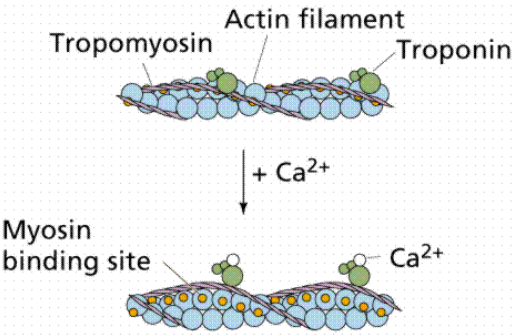


[myosin structure]





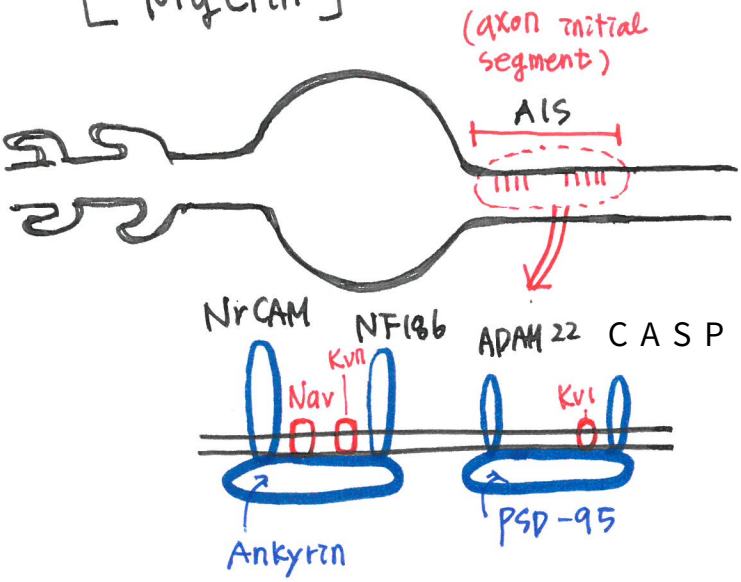


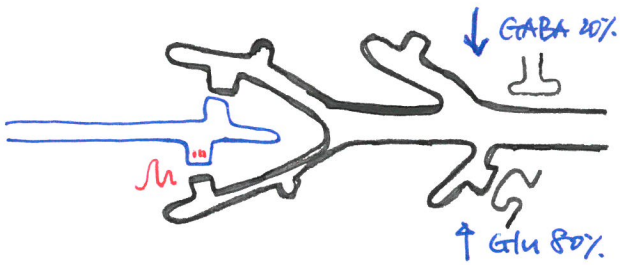


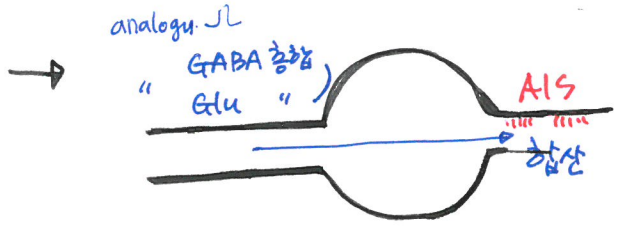
- ATP ⟸ glucose ⟸ CO_2 대기
  aas ⟸ (TCA cycle) H_2O 대양
- G-actin : 374 aas ← glucose
  ↓
  F-actin 우리는 대기와 대양의 후손이다.
- 인지질막 $(CH_2)_n$
- 지질 세포/cell : 60,000개 ATP/sec
  단백질 세포/cell : ★ 2100만 ATP/sec
  ATP ⟶ ADP

(∴) 생물학은 '단백질'에 관한 내용이 핵심이다.

[Myelin]





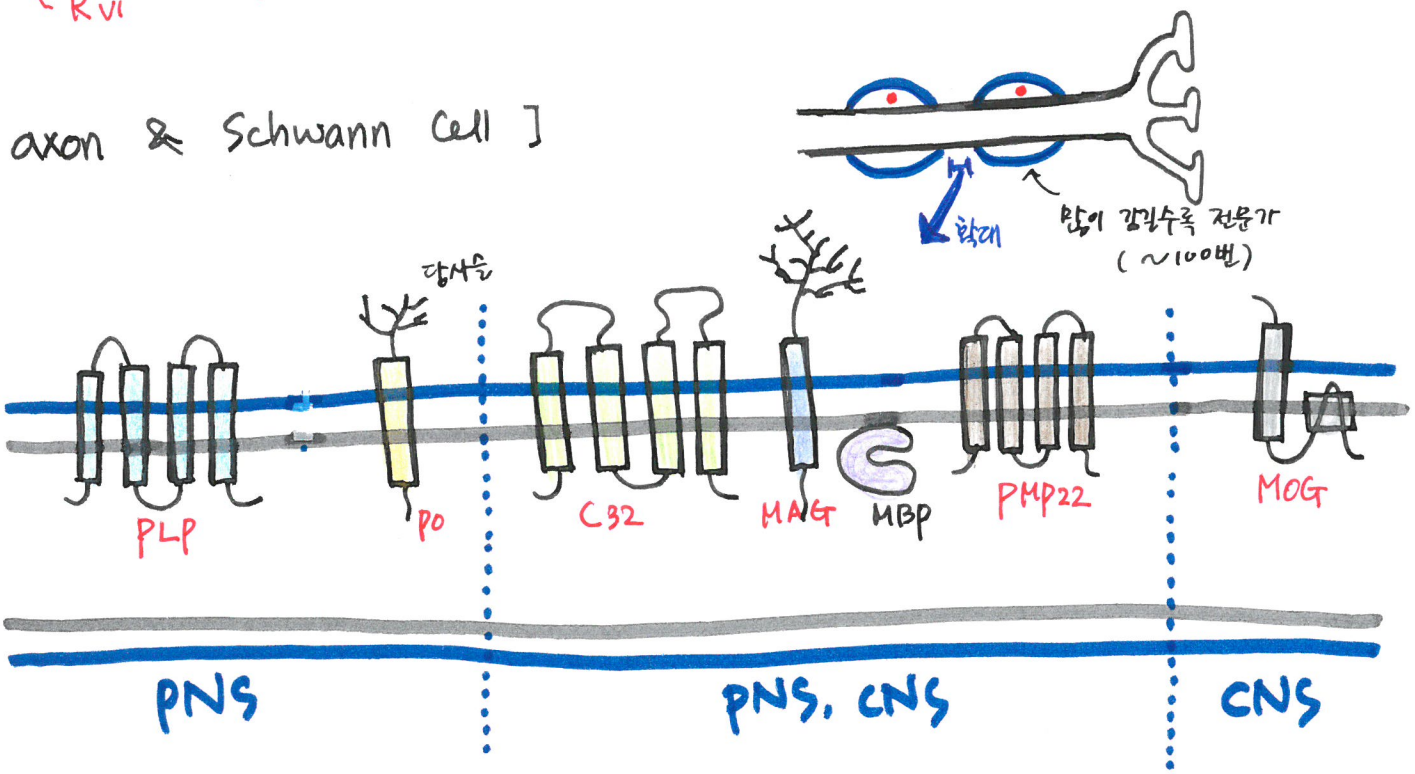


NrCAM : cell adhesion molecule
NF186 : neurofascin
ADAM22 : APP 처럼 잘라지는 단백질

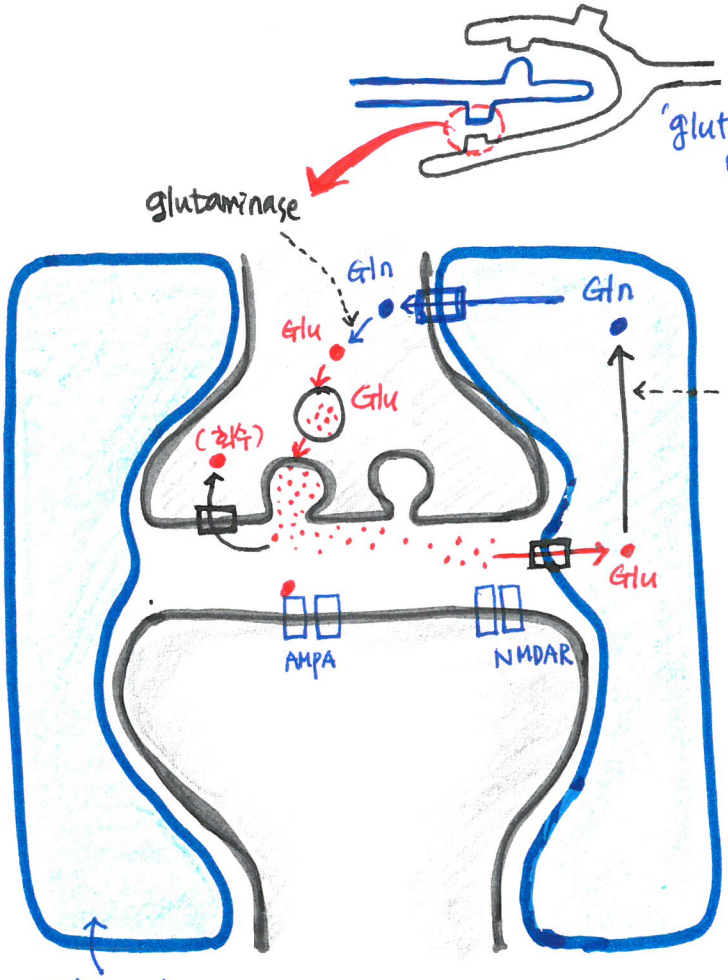
Nav : Na channel voltage dependent
Kvn : K " " "
Kvi

* 세포생물학
(cell biology) 1000 page 교재
→ 세포 하나가 '학문' 지체
세포골격 관련 내용이 50%

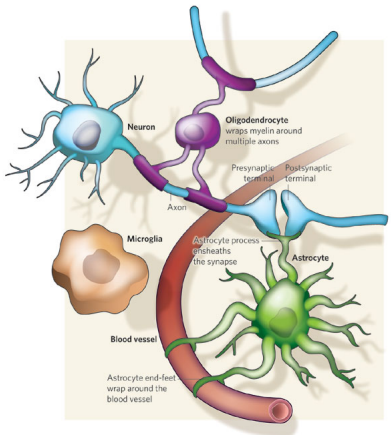
[axon & Schwann cell]

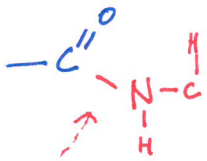


[dendrite] & astrocyte



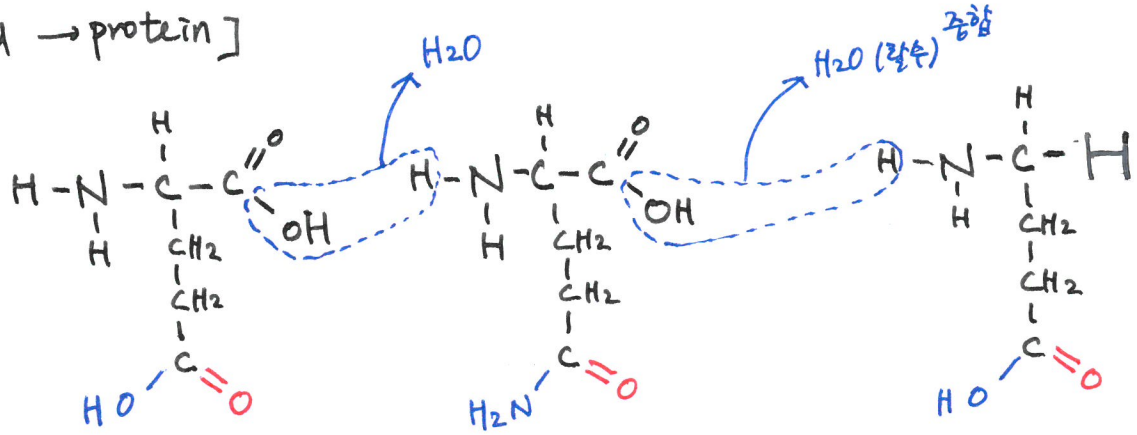
'glutamate' 위험하므로
방출되어 작용을 마치면 즉시 회수한다.
synapse 전후막 사이에 'astrocyte'가
감싸고 있다.





중합

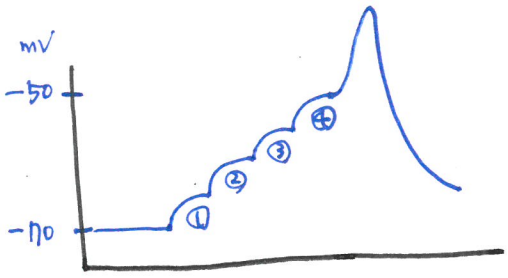
[aa → protein]

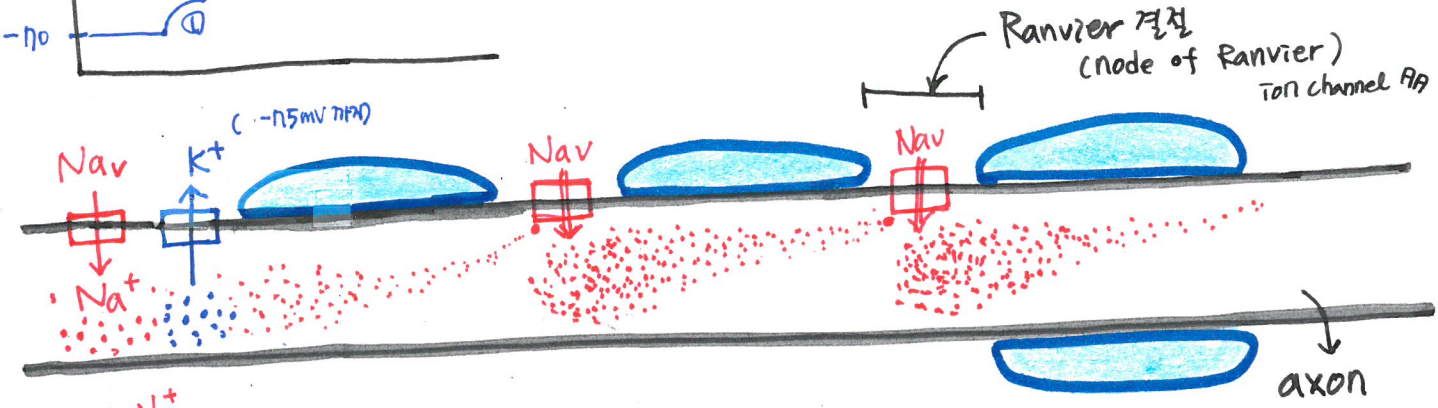


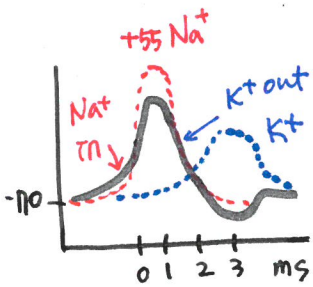
Glu Gln GABA

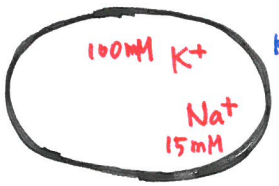
* (탈수 중합
가수 분해

[action potential]







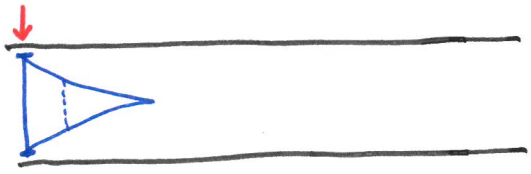


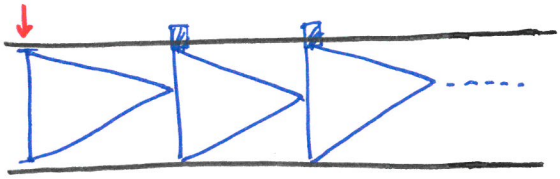
Na+ in K+ out

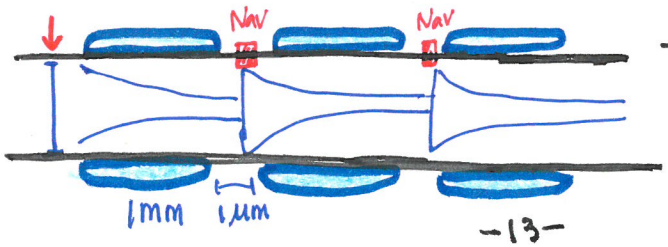
dendrite

non-myelin
(해양무척추동물)
→ 무수성경

myelin
→ 유수신경







- Schwann cell의 myelination 과정에는 수십년의 시간(=훈련)이 필요하다. (20년)

연결 유지를 위해서 "AIS"의 6개 단백질이 촘촘히 박혀 있어야 한다

(Ankyrin - NrCAM, NF186
PSD-95 - ADAM22, GASPR2)

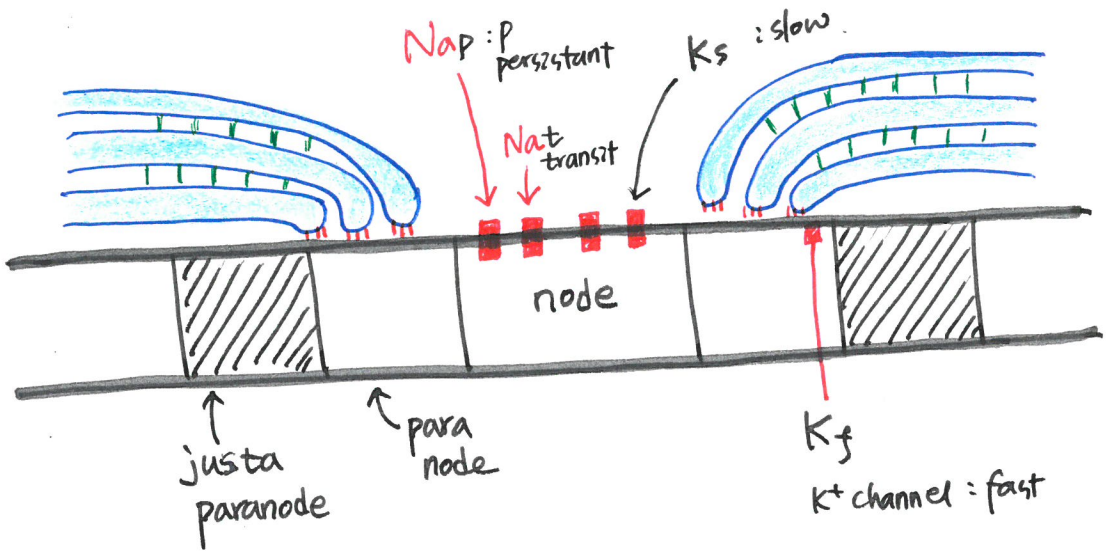
→ stress를 받으면 감긴 myelin이 풀려버린다.

- 무척추동물 → AP 전달 slow
오징어 축삭은 크기가 크다. (500μm)

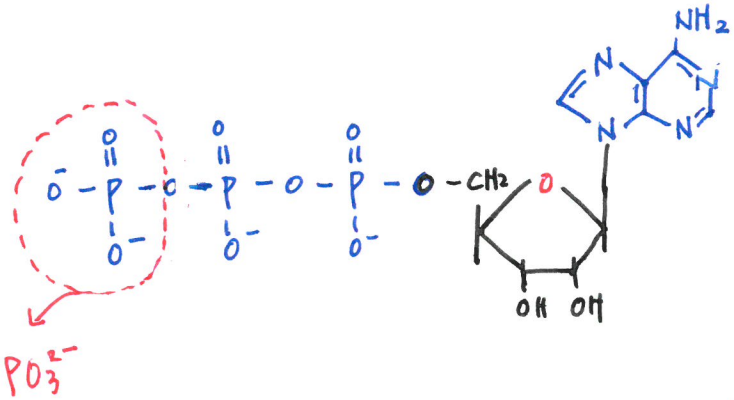
⇒ "진화"는 세포증식이 많아지는 과정이다.

→ 위대한 Schwann cell 덕분에 신경신호전달속도↑
풀리면 → 주계각변 100번까지 감긴다.

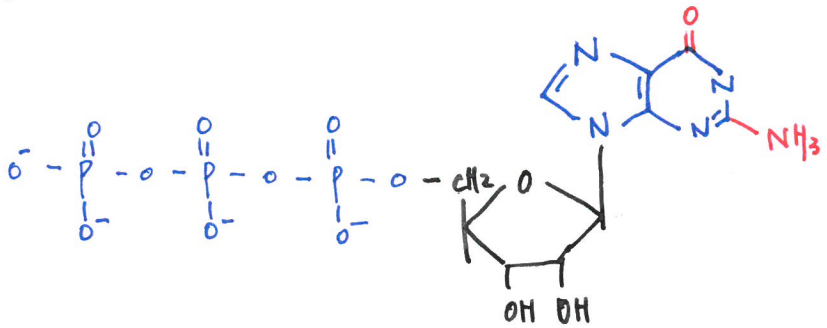
[myelination]

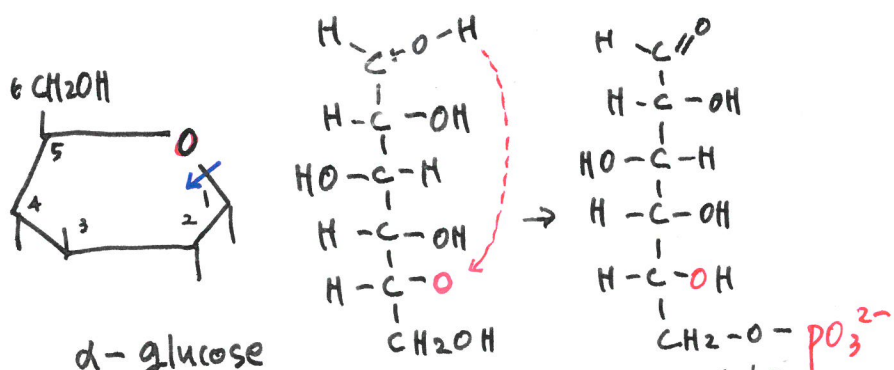


[ATP structure]

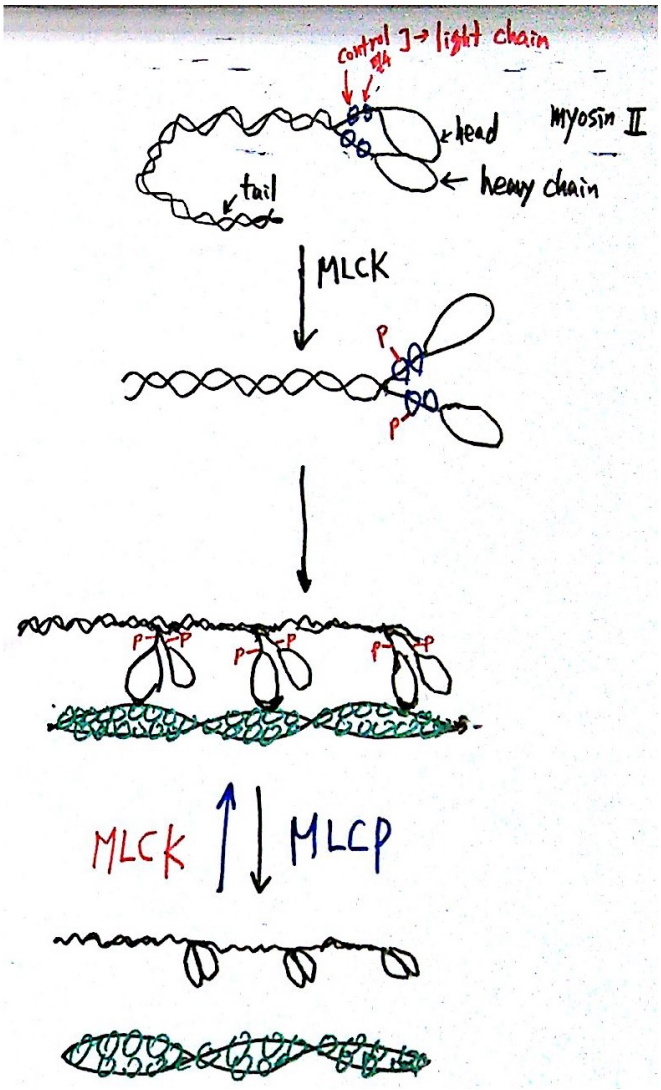


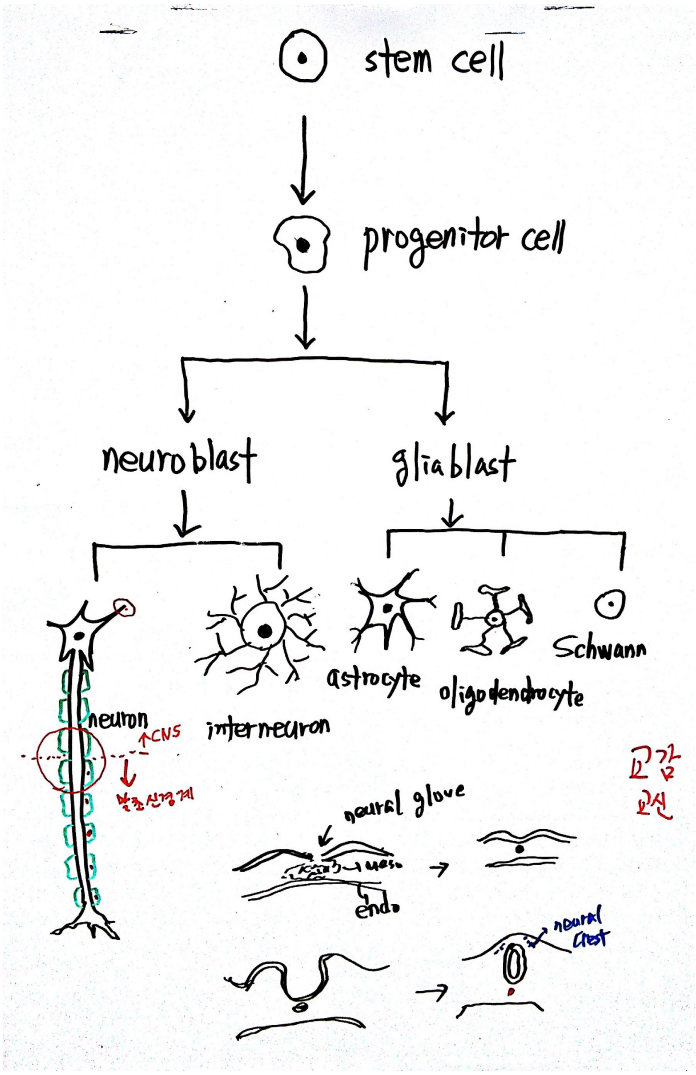
ATP ⇄ ADP + Pi (CPO_3^{2-})

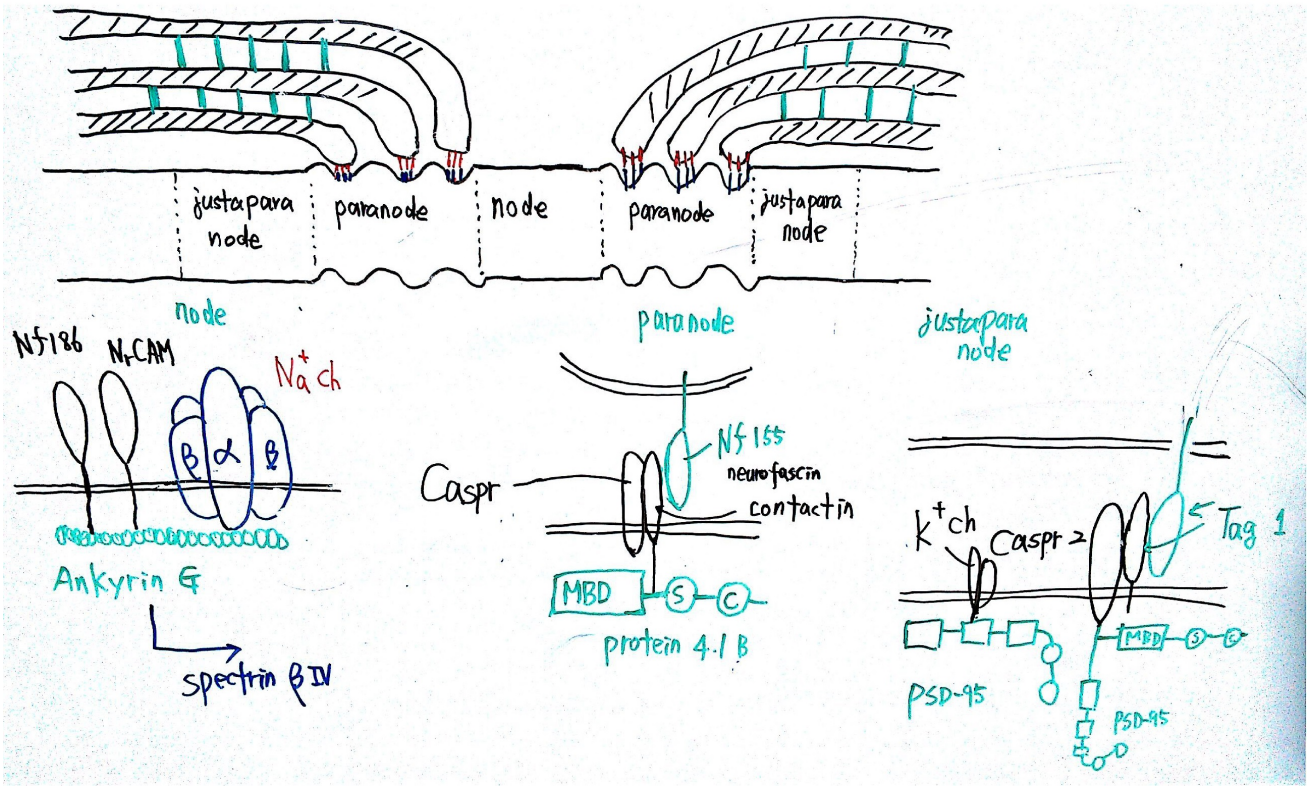




[참고자료] 제5회 특뇌 6, 7강 · 성경세포. Schwann 세포







[aa, purine, pyrimidine]

glucose → photo synthesis
gluconeogenesis

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

$3O_2$ (H_2O)
$3O_2$ (CO_2)

• 대기 중 O_2 생성 이전에도 생명이 있었다.
가장 중요한 기원은 "CO_2" 다.

제9회 137억년 우주의 진화 제6강 참조