



NERV IMPULSLARINING TARQALISH MEXANIZM

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Anotatsiya. *Ushbu maqolada nerv impulsining hosil bo`lishi, tarqalishi va sinaps orqali uzatilish mexanizmlari yoritilgan. Neyronlarda elektr zaryadlarining o`zgarishi natijasida hosil bo`ladigan harakat potentsiali asab tizimi faoliyatining asosini tashkil etadi. Tinchlik potentsiali davrida natriy-kaliy nasosi yordamida membrana zaryadi barqaror saqlanadi, tashqi ta`sir natijasida esa depolyarizatsiya yuz berib, harakat potentsiali shakllanadi. Miyelinli tolalarda impuls Ranvier tugunlari orqali sakrab o`tadi va yuqori tezlikda tarqaladi, miyelinli tolalarda esa ketma-ket depolyarizatsiya orqali sekinroq o`tadi. Akson uchiga yetgan impuls sinaps orqali keyingi neyron yoki effektor organga uzatiladi. Bu jarayonda kaltsiy ionlari va neurotransmitterlar (atsetilxolin, dopamin, serotonin) muhim rol o`ynaydi. Nerv impulsining bu ketma-ket jarayonlari organizmda sezgi, harakat va refleks faoliyatlarining muvofiqligini ta`minlaydi.*

Kalit so`z: *nerv impulsi, tinchlik potentsiali, harakat potentsiali, miyelin, sinaps, neurotransmitter, depolyarizatsiya.*

KIRISH

Nerv tizimi — organizmning tashqi va ichki muhitga javob berish, sezgi ma`lumotlarini qayta ishlash va muskullar hamda bezlarni boshqarish funksiyalarini bajaruvchi eng muhim va murakkab biologik tizimlardan biridir. Ushbu tizimning asosiy funktsional birligi bo`lgan neyronlar orasida axborot asosan **elektrik impuls**lar — nerv impuls

(harakat potentsiallari) shaklida uzatiladi. Nerv impulsi membrana bo`ylab zaryadning vaqtinchalik o`zgarishi natijasida yuzaga keladi va uning hosil bo`lishi hamda tarqalishi neyrofiziologiyaning markaziy ob`ektidir.

Nerv impulsining molekulyar va elektrofiziologik asosini tushunish — nafaqat normal fiziologiyani, balki turli asab kasalliklari (masalan, multiple



skleroz, periferik neyropatiyalar, epilepsiya) patofiziologiyasini izohlashda ham muhim ahamiyatga ega. Impulslarning membrana potentsialidagi o'zgarishlar (dam olish potentsiali, depolyarizatsiya, repolyarizatsiya) va bu jarayonlarda ishtirok etuvchi natriy (Na^+), kaliy (K^+) hamda kalsiy (Ca^{2+}) ion kanallari va nasoslarning xatti-harakati axborot uzatilishining samaradorligi va tezligini belgilaydi. Shuningdek, miyelin qoplarning mavjudligi va Ranvier tugunlari orqali sodir bo'ladigan saltator o'tish mexanizmi impulslar tezligini keskin oshiradi va nerv tolalarining funksional xususiyatlarini aniqlaydi.

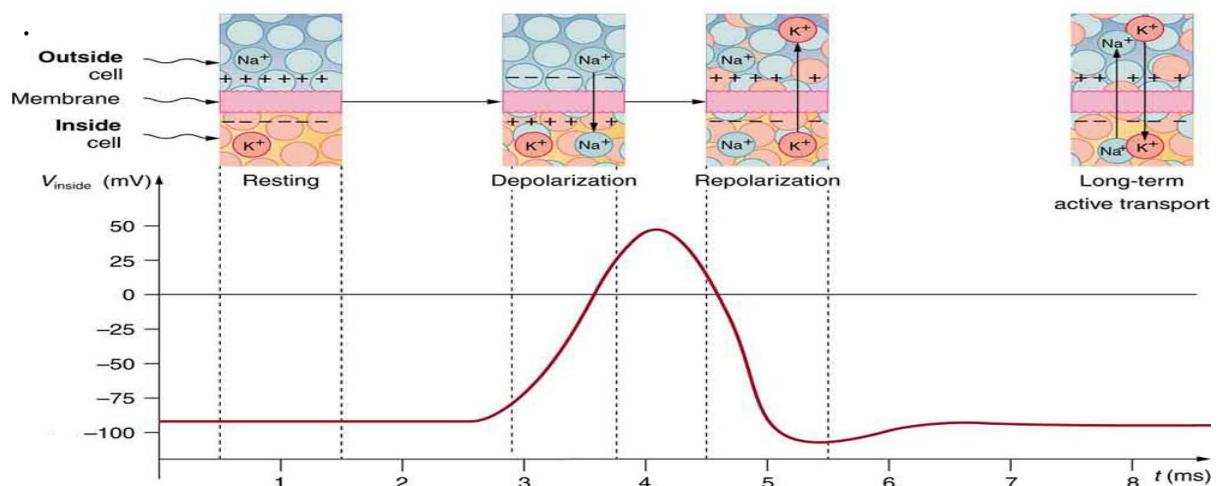
ASOSIY QISM

Tinchlik potentsiali Neyron nerv impulsini faol ravishda uzatmayotgan paytda u tinchlik holatida bo'ladi va asab impulsini qabul qilish yoki uzatishga tayyor holatda turadi. Bu paytda natriy-kaliy nasosi neyron hujayra membranasini bo'ylab elektr zaryadlarining muvozanatini saqlab turadi. Ushbu nasos — bu faol transport mexanizmi bo'lib, u

Harakat potentsiali Nerv impulsi — bu harakat potentsiali bo'lib, u neyron membranasini bo'ylab harakatlanadigan elektr o'zgarishdir. Harakat potentsiali

ATP energiyasi yordamida natriy ionlarini (Na^+) hujayra tashqarisiga, kaliy ionlarini (K^+) esa hujayra ichiga o'tkazadi. Natriy-kaliy nasosi hujayra membranasidagi maxsus tashuvchi oqsillar yordamida ionlarni ularning past konsentratsiyali joyidan yuqoriroq konsentratsiyaga qarab ko'chiradi. Natijada, neyron ichida kaliy ionlari ko'proq, tashqarisida esa natriy ionlari ko'proq to'planadi. [Guyton, A. C., & Hall, J. E. (2021)] Bu ionlarning notekis taqsimlanishi hujayra membranasini bo'ylab tinchlik potentsiali deb ataladigan elektr gradientini hosil qiladi. Neyronning tinchlik potentsiali odatda -70 millivolt (mV) atrofida bo'ladi. Tinchlik potentsialining barqaror saqlanishi asab impulslarining hosil bo'lishi va uzatilishi uchun nihoyatda muhimdir. Agar ushbu muvozanat buzilsa, neyronning qo'zg'aluvchanligi ham o'zgaradi, bu esa asab tizimi faoliyatiga jiddiy ta'sir ko'rsatadi. [Bear, M. F., Connors, B. W., & Paradiso, M. A. (2020)].

neyronning tinch holatidagi potentsiali kimyoviy yoki elektr signallar ta'sirida o'zgarganda yuzaga keladi

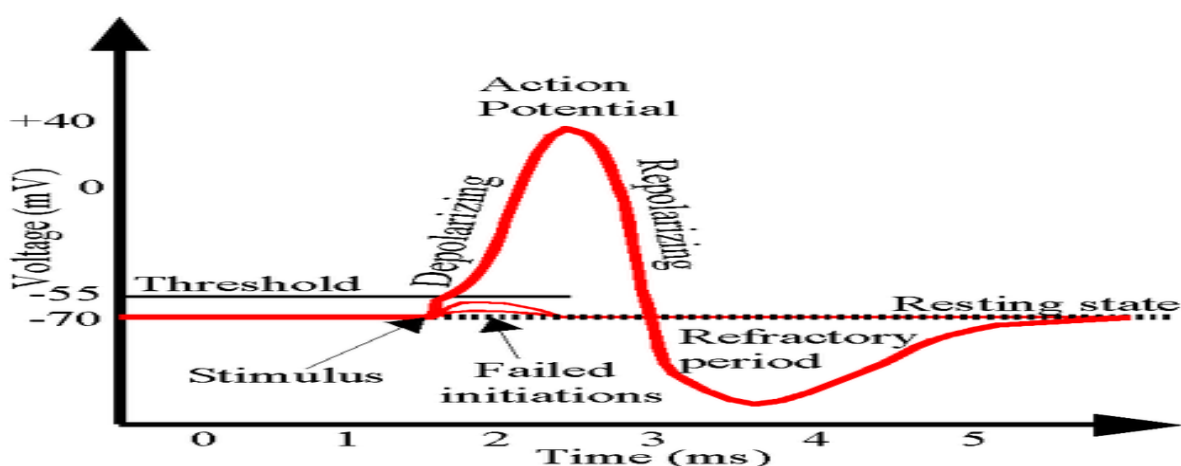




Uning davomida membrana potentsiali qisqa vaqt ichida manfiy qiymatdan musbat qiymatga o'tadi. Buning sababi shundaki, natriy ion kanallari ochiladi va natriy ionlari tezda hujayra ichiga oqib kiradi, bu esa membrana ichki qismining zaryadini

musbatlashtiradi. Keyinchalik kaliy ion kanallari ochilib, kaliy ionlari hujayradan tashqariga chiqadi va natijada membrana potentsiali yana manfiy holatga qaytadi.

[Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S. A., & Hudspeth, A. J]



Bu o'zgarishlar ketma-ketligi — depolyarizatsiya, repolyarizatsiya va refrakter davr — nerv impulsining asosiy fiziologik bosqichlarini tashkil etadi. Harakat potentsiali shakllangach, u akson bo'ylab sinaps tomon tarqaladi va keyingi neyron yoki effektor organga o'tadi. [Purves, D., Augustine, G. J., Fitzpatrick, D., Hall, W. C., & Lamantia, A. S.]

Nerv impulslarining tarqalishi.

Nerv impulslarining o'tishi ikki xil nerv tolalar orqali amalga oshiriladi: ular miyelinli va miyelinsiz nerv tolalaridir

Miyelinli nerv tolalarida akson atrofini miyelin qobig'i o'rab turadi. Bu qobiq shvann hujayralari yoki markaziy asab tizimida oligodendrositlar tomonidan hosil qilinadi. Miyelinning asosiy vazifasi — elektr impulslarning

izolyatsiyasini ta'minlash va signal o'tishini tezlashtirishdir. Miyelin qobig'ida har 1–2 mm masofada Ranvier tugunlari joylashgan bo'lib, ion almashinuvi faqat shu tugunlar orqali amalga oshadi. Shu sababli nerv impulsining tarqalishi saltator (sakrab o'tuvchi) tarzda kechadi: ya'ni harakat potentsiali bir tugundan keyingisiga "sakraydi". Bu mexanizm natijasida impuls o'tish tezligi 100 m/s gacha yetishi mumkin. Bunday yuqori tezlik organizmda tezkor reflekslar, harakat muvofiqligi va murakkab nerv tarmoqlarida axborot almashinuvi uchun muhimdir.

Miyelinsiz tolalar miyelin qobig'iga ega emas, lekin ularning aksonlari odatda bir nechta tolalar bilan birga bitta shvann



hujayrasi tomonidan o'ralgan bo'ladi. Bunday tolalarda impuls o'tishi ketma-ket depolyarizatsiya orqali, ya'ni butun membrana bo'ylab sodir bo'ladi. Shu sababli, ularning o'tish tezligi nisbatan sekin — odatda 0,5–2 m/s oralig'ida bo'ladi.

Shunga qaramay, miyelinsiz tolalar organizmda nihoyatda muhim rol o'ynaydi. Ular sezgir (afferent) va vegetativ (efferent) yo'llarning asosiy tarkibiy qismi bo'lib, og'riq, issiqlik, bosim va ichki organlardan kelayotgan vegetativ signallarni markaziy asab tizimiga yetkazadi. Masalan, teridagi og'riq retseptorlari, ichki organlardan chiqadigan afferent nervlar, yurak va oshqozon faoliyatini boshqaruvchi tolalar asosan miyelinsizdir. [Marieb, E. N., & Hoehn, K. (2019). *Human Anatomy & Physiology*]

Nerv impulsining sinaps orqali uzatilishi

Nerv impulsining bir neyron aksonidan boshqasiga o'tishi sinaps orqali amalga oshadi. Asosan, odam asab tizimida kimyoviy sinapslar uchraydi.

Ular uch qismdan iborat:

- presinaptik membrana
- sinaptik yoriq
- postsinaptik membrana.

Presinaptik terminalda neurotransmitterlarga to'la sinaptik pufakchalar joylashgan. Impuls bu sohaga yetganda kaltsiy ionlari (Ca^{2+}) kanallari ochiladi va kaltsiy hujayraga kiradi. Natijada pufakchalar membrana bilan qo'shilib, neurotransmitterlarni sinaptik

yoriqqa chiqaradi. Neyrotransmitterlar (masalan, atsetilxolin, dopamin, serotonin) postsinaptik membranadagi retseptorlarga bog'lanib, yangi harakat potentsiali hosil qiladi. So'ngra mediatorlar parchalanadi yoki qayta so'riladi — bu sinapsni keyingi signal uchun tayyorlaydi.

XULOSA

Nerv impulsining hosil bo'lishi va uzatilishi ketma-ketlikda amalga oshadigan murakkab, ammo mukammal fiziologik jarayondir. Avvalo, neyron tinchlik potentsiali holatida bo'lib, bunda natriy-kaliy nasosi yordamida hujayra ichida manfiy, tashqarisida esa musbat zaryad saqlanadi. Tashqi ta'sir natijasida membrana depolyarizatsiyaga uchraydi — natriy ionlari hujayraga kirib, harakat potentsiali hosil bo'ladi. Keyinchalik kaliy ionlarining chiqishi orqali membrana repolyarizatsiyalanadi va neyron o'z dam olish holatiga qaytadi.

Hosil bo'lgan elektr signal akson bo'ylab tarqaladi. Agar tolalar miyelin qobig'iga ega bo'lsa, impuls Ranvier tugunlari orqali "sakrab" o'tadi, bu esa o'tish tezligini bir necha baravar oshiradi. Miyelinsiz tolalarda esa impuls butun membrana bo'ylab ketma-ket tarqaladi.

Akson uchiga yetgan impuls sinaps orqali keyingi hujayraga uzatiladi. Bu jarayonda kaltsiy ionlari kirib keladi, sinaptik pufakchalar yorilib, neurotransmitterlar (masalan, atsetilxolin, dopamin, serotonin) sinaptik yoriqqa ajraladi. Ular postsinaptik membrana retseptorlari bilan bog'lanib, yangi



hujayrada navbatdagi harakat potentsialini keltirib chiqaradi.

Shu tarzda, nerv impulsining hosil bo'lishi, tarqalishi va sinaps orqali uzatilishi — asab tizimi faoliyatining

asosiy mexanizmi bo'lib, u organizmda sezgi, harakat, refleks va fikrlash jarayonlarining muvofiqligini ta'minlaydi.

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