Patrician College of Arts and Science

Department of Psychology

Biological Basis of Behaviour - I

Subject Code : SAT1B

Odd Semester

Presented By
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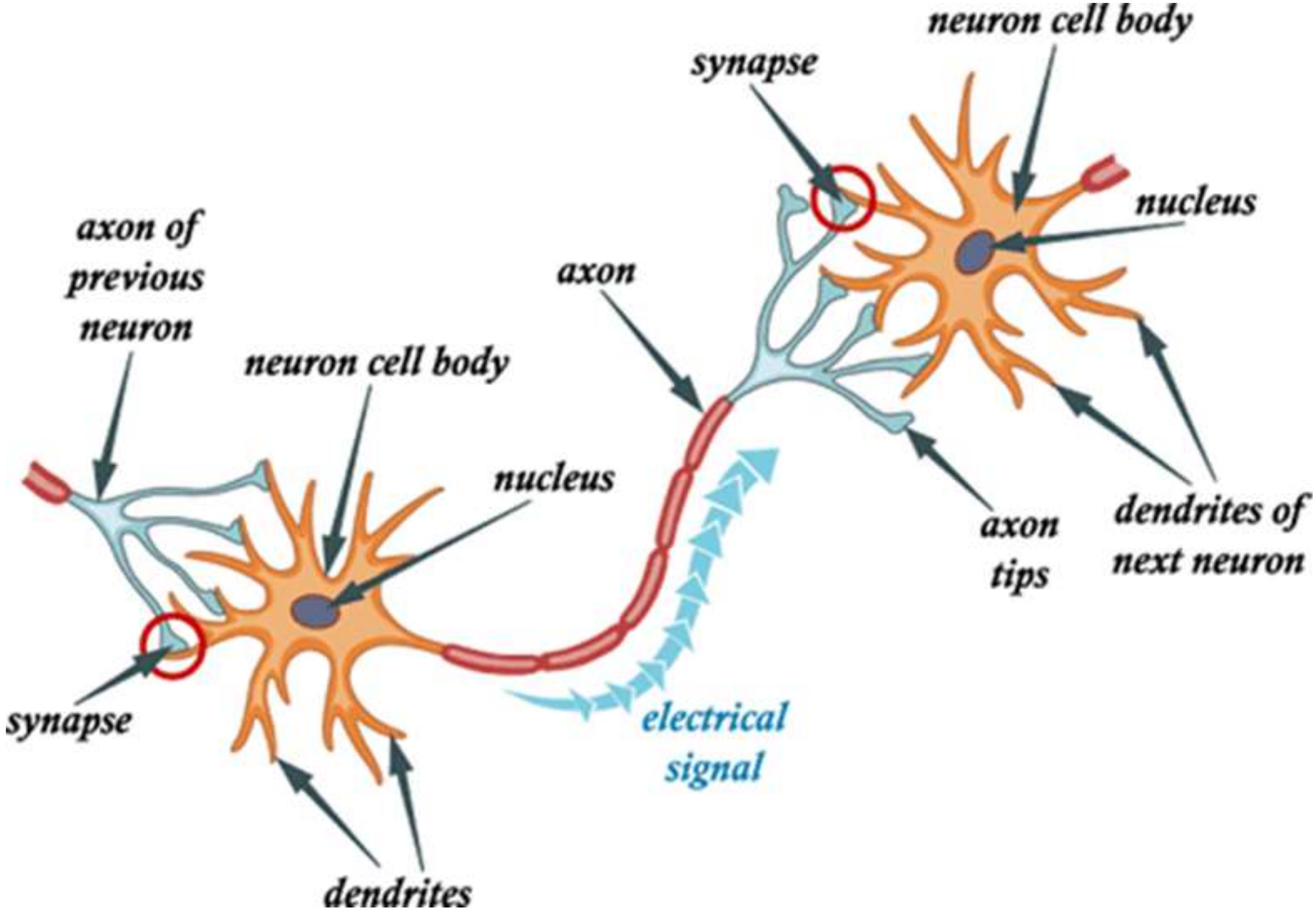
neuron cell body
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electrical
signal
dendrites

THE NEURAL IMPULSE CYCLE

- The nerve impulse is the reversal in the charge of the cell membrane, which spreads along the cell membrane forming an electrical current.

- Resting Potential – what happens when the neuron is at rest.
- Action Potential -   Occurs when a neuron sends information down an axon

i) Depolarisation

ii) Repolarisation

Resting Membrane Potential

- Recording the membrane potential: difference in electrical charge between inside and outside of cell
- Inside of the neuron is negative with respect to the outside
- Resting membrane potential is about –70mV
- Membrane is *polarized* (carries a charge)

Ionic Basis of the Resting Potential

- Factors contributing to even distribution of ions
- Random motion – particles tend to move down their concentration gradient
  - Electrostatic pressure – like repels like, opposites attract
- Factors contributing to uneven distribution of ions
  - Selective permeability to certain ions
  - Sodium-potassium pumps

Ions Contributing to Resting Potential

- Sodium (Na^+)
- Chloride (Cl^-)
- Potassium (K^+)
- Negatively charged proteins (A^-)

Resting potential results from

(1) the concentration of Na+ is higher outside,

(2) the concentration of Cl is higher outside,

(3) the concentration of K+ is higher inside, and

(4) various negatively charged protein ions are trapped inside

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Ions Contributing to Resting Potential

- Sodium (Na^+)
- Chloride (Cl^-)
- Potassium (K^+)
- Negatively charged proteins (A^-)
  - Synthesized within the neuron
  - Found primarily within the neuron

Generation and Conduction of Postsynaptic Potentials (PSPs)

- Neurotransmitters bind at postsynaptic receptors
- These chemical messengers bind and cause electrical changes
  - Depolarizations (making the membrane potential less negative)
  - Hyperpolarizations (making the membrane potential more negative)

The Neuron at Rest

- Ions move in and out through ion-specific channels
- K^+ and Cl^- pass readily
- Little movement of Na^+
- A^- don’t move at all, trapped inside

The Neuron at Rest

Equilibrium Potential (Hodgkin-Huxley model)

- The potential at which there is no net movement of an ion – the potential it will move to achieve when allowed to move freely
- Na^+ = 120mV
- K^+ = 90mV
- Cl^- = -70mV (same as resting potential)

The Neuron at Rest Continued

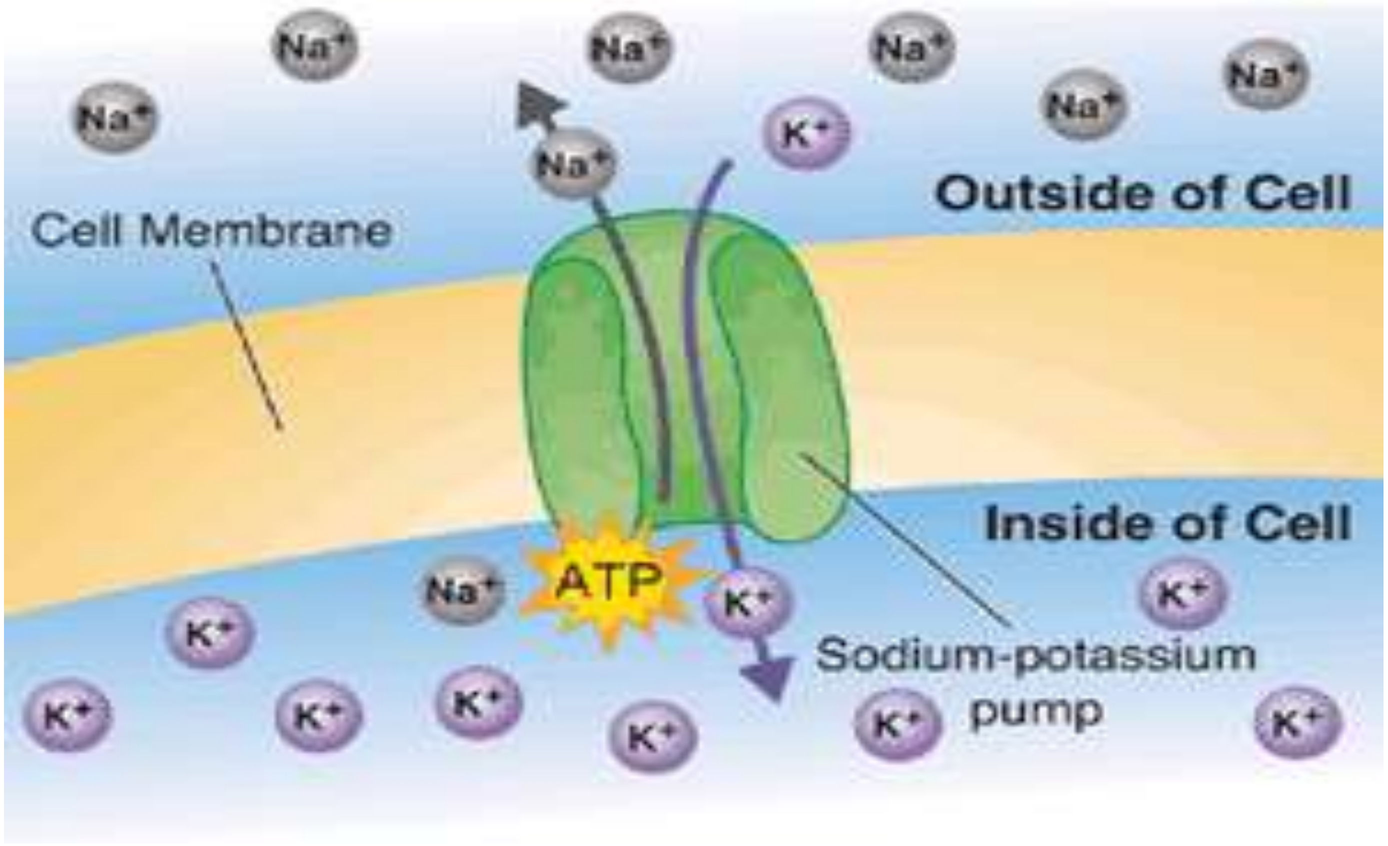
- Na^+ is **driven in by both** electrostatic forces and its concentration gradient
- K^+ is **driven in** by electrostatic forces **and out** by its concentration gradient
- Cl^- is at equilibrium
- Sodium-potassium pump – active (uses ATP) force that exchanges 3 Na^+ inside for 2 K^+ outside

Conduction of APs

- All-or-none – when threshold is reached the neuron "fires" and the action potential either occurs or it does not
- When threshold is reached, voltage-activated ion channels are opened

SODIUM POTASSIUM PUMP

- Sodium Potassium Pump- energy consuming process involved in the maintenance of the resting potential.



SODIUM POTTASSIUM PUMP

- The process of moving sodium and potassium ions across the cell membrane is an active transport process involving the hydrolysis of ATP to provide the necessary energy.

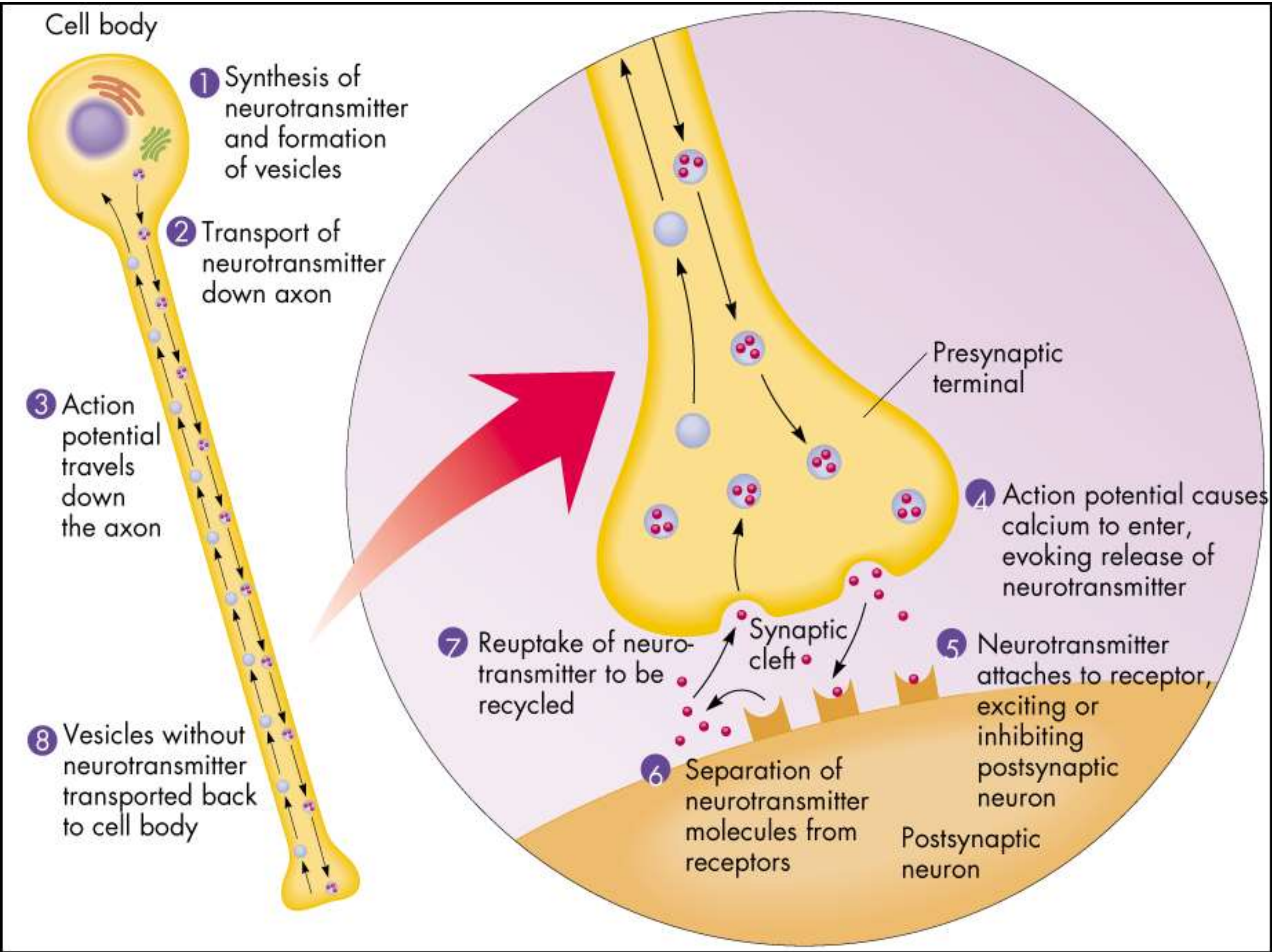
- Potassium ions tend to move out of the neuron because of their higher concentration inside the cells, although this tendency is partially offset by the internal negative potential .

- However the sodium potassium pump pumps out sodium ions as rapidly as they pass in and pumps in potassium ions as they pass out

- For every three sodium ions in it pushes into the cell it two ottassium ions it send out

GENERATION OF POST SYNAPTIC POTENTIALS .
How are neural signals created?

- When neurons fire, they release chemicals called neurotransmitters
- These chemicals diffuse across the synaptic cleft and bind with the post – synaptic receptors in a lock and key fashion.



Cell body
1 Synthesis of neurotransmitter and formation of vesicles
2 Transport of neurotransmitter down axon
3 Action potential travels down the axon
8 Vesicles without neurotransmitter transported back to cell body
Presynaptic terminal
4 Action potential causes calcium to enter, evoking release of neurotransmitter
7 Reuptake of neuro-transmitter to be recycled
Synaptic cleft
5 Neurotransmitter attaches to receptor, exciting or inhibiting postsynaptic neuron
6 Separation of neurotransmitter molecules from receptors
Postsynaptic neuron

WHAT ARE THE EFFECTS?

- When neurotransmitter molecules bind to post –synaptic receptors, they typically have two effects.

a) They may **depolarise** the receptive membrane (decrease the resting potential, from -70 to -67 mv)

b) They may **hyperpolarise** (increase the resting membrane potential from -70 to -72 mv).

- Post synaptic depolarizations are called **excitatory post synaptic potentials (EPSP).**They increase the likelihood of neuronal firing.
- Post synaptic hyper - polarizations are called **inhibitory post synaptic potential (IPSP).** They decrease the likelihood of neuronal firing.

Both EPSP and IPSP are graded potentials : ie., the amplitudes of E PSP's and IPSP's are proportional to the intensity of the stimulus

CONDUCTION OF POST SYNAPTIC POTENTIALS

- EPSP's and IPSPs travel passively from their sites of generation at synapse
- usually on the dendrites or cell body in much the same way that electrical signals travel through the cable.
- Transmission of post synaptic potentials has two characteristics.

1) It is rapid, almost instantaneous irrespective of whether they are brief or enduring.

2) They are decremental, ie., they decrease in amplitude as they travel through the neuron.

INTEGRATION OF POST SYNAPTIC POTENTIALS AND GENERATION OF ACTION POTENTIALS

- A neuron's action potentials are triggered at the axon hillock when neuron is depolarized to the point that the membrane potential at the hillock reaches about -65 mV. This is the threshold of excitation for many neuron.

- Action potential is a massive momentary reversal of the membrane potential from about -70 to about +50 mV. This last for 1 millisecond.

- Unlike EPSPs and IPSPs, Action potentials are not graded. They follow the all or none law.

- Most neurons receive hundreds of synaptic contacts. Whether or not a neuron fires is determined by the *adding together* (integration) of what goes on at many *presynaptic neuron synapses*

Integration

- Adding or combining a number of individual signals into one overall signal
- Spatial summation – integration of events happening at different places
- Temporal summation – integration of events happening at different times

INTEGRATION OF POST SYNAPTIC POTENTIALS AND GENERATION OF ACTION POTENTIALS

There are two kinds of neural integration:

- Spatial summation (EPSPs + EPSPs; IPSPs + IPSPs; EPSPs + IPSPs) - It shows how local EPSPs that are produced simultaneously on different parts of the receptive membrane sum to form a greater EPSP .

- Temporal Summation: (EPSPs + EPSPs; IPSPs + IPSPs) – It shows how post synaptic potentials produced in rapid succession at the same synapse sum to form a greater signal

Thank you

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