7.012 Solutions to Neurobiology Section Problem 2b

a)

protein complex	ion(s) moved	direction
Na+/K+ ATPase	*Na+* *K+*	*out* *in*
resting K+ channel	*K+*	*out*

ii) How do these complexes work in concert to establish the resting membrane potential?

The Na+/K+ ATPase establishes the concentration gradient.
The resting K+ channel establishes the charge difference across the membrane.

b)

protein complex	ions moved	direction	depolarization or repolarization
voltage-gated Na+ channel	*Na+*	*in*	*depolarization*
voltage-gated K+ channel	*K+*	*out*	*repolarization*

c) If you increase K^+ ion concentration outside the neuron, how would the resting membrane potential change? Why?

The resting membrane potential would become less negative, ie. move towards 0.
By increasing the extracellular K^+ ions, you decrease the driving force on K^+. Less K^+ leaves the cell through the resting K^+ channel, so fewer negative charges are left behind.

d) Would the above change make the neuron more or less likely to fire an action potential? Why?
It would make the neuron more likely to fire because the neuron is depolarized.

e) i) How is the electric signal converted to a chemical signal in the pre-synaptic cell?

The action potential invades the terminus and depolarizes the membrane. This opens voltage-gated Ca^{++} channels. Ca^{++} moves in causing vesicle fusion and neurotransmitter release.

ii) How is this chemical signal transduced back into an electric signal in the post-synaptic cell?

Neurotransmitter binds to a receptor on the post-synaptic cell. If this is a neuromuscular junction, and an excitory presynaptic neuron releasing ACh, then ACh would bind to the ACh receptor on the muscle cell allowing Na^+ to enter the cell causing depolarization. Voltage-gated Na^+ channels open. If this is sufficient to cause an action potential in the postsynaptic cell, the depolarization will allow voltage-gated Ca^{++} channels to open allowing Ca^{++} to enter the cell and triggering contraction of the muscle fibers.