First 2009
VIVA 8

In this viva you will be asked to discuss cell membrane physiology and electrolyte disturbances.
Draw a cell membrane.

Dram a cell membrane

is a bilayer of lipids and protiens and is on average 5-7.5nm thick
it has a hydrophobic tail and hydrophilic head, hence the orientation
it is punctuated with receptors, channels, surface protiens and transcellular protiens.

"What are the main methods of transport across cell membranes?"

- diffusion
  - simple diffusion- if the substance is lipid soluble or via water porins
  - facilitated diffusion -carrier mediated diffusion process
- active transport
  - requires an addition source of energy rather than just kinetic (usually ATP)

"What is the resting membrane potential and how is it maintained?"
is a fundamental and essential property of all cells. The membrane potential is an electrical gradient that results from the differences in concentrations of charged organic and inorganic ions across the cell membrane. For most mammalian cells the resting membrane potential is negative to the outside, usually -60 to -70 mV. The predominant ions involved are organic anions and K^+ inside the cell and Na^+ and Cl^- on the outside. This ions have two driving forces, the concentration gradient and the electrical gradient. The distribution of ions across the cell will equal equilibrium when these two forces are balanced. This relationship was first described by Nernst in 1888.

"Please write the Nernst potential equation"
Nerst equation, $E = (RT/zF)\ln([ion_{outside}]/[ion_{inside}]$ where E is the Nerst potential, R is the gas constant, T is the temperature in Kelvins, z is the valence of the ion and F is faraday's constant. This can be simplified, if the ion is single valence (K, Cl, Na) then the first part of the equation can be simplified to 58. Therefore it is possible to calculate the Nernst potential for these important ions. $E_{potassium} = 58\text{Log}_{10}(4/140) = -90$, $E_{chloride} = -58\text{Log}_{10}(116/4) = -85$, $E_{sodium} = 58\text{Log}_{10}(145/12) = 65$. This introduces a new concept which is selective permiability. The Nerst potential for potassium and chloride is similar to the resting membrane potential, and this is consistent with the fact that the cell membrane is highly permiable to these ions. The sodium potential is vastly different to the RMP and it follows that the cell membrane is not permiable to this ion (otherwise the RMP would beome more positive). Two key elements establish and maintain the membrane potenial; cell membrane channels which are selectively permiable to ions and cell membrane pumps which actively transport charged particles against electrochemical gradients. There is a slight permiability to sodium but the Na.K.ATPase pump ensures that the RMP does not become more +

"Describe Gibbs-Donnan Forces"
situation created with a semipermiable membrane. Some ions (eg Na^+ and Cl^-) freely move but others (eg large anion proteins) don't. More Na^+ will exist on the side with the large anions and more Cl^- on the other side to ensure chemico-electrical equilibrium. Despite electrical equilibrium there is now osmotic disequilibrium and water will move into the intravascular side (disrupting the chemico-electrical state). The result is opposing osmotic and electo-chemical gradients. As a result of increased osmols on the intravascular side, there is an augmentation of the plasma oncotic pressure. This is also very important for the stability of the cell volume where the cell membrane is also semipermiable and intracellular proteins and organic phosphates cause a donnan effect into the cell and the extrusion of increased cations by the Na-K-ATPase pump cause a reverse donnan effect (double donnan). It makes a small contribution to the resting membrane potential.