

currents and depolarizing calcium current. Inactivation of the calcium current with persistent activation of potassium currents (predominantly I_{K_r} and I_{K_s}) causes phase 3 repolarization. Currents that result in membrane depolarization are grouped at the top of the figure above the action potentials, while repolarizing currents are shown below the action potentials. **B.** A surface ECG representation of sinus rhythm is shown with respective intracardiac action potentials that are active during each phase of the ECG. Each cardiac conduction region's action potential is shown in the upper portion of the panel, with colors reflected in the ECG segment shown in the lower portion of the panel. Note that during the P wave, atrial depolarization is active. During the PR interval, the AV nodal, His, bundle branches, and Purkinje fibers are active (in sequence), although these action potentials are not discernible on the surface ECG. During the QRS interval, ventricular action potentials are active, with the QRS morphology most reflective of the sequence of ventricular tissue action potential activation. The ST segment is predominantly determined by the plateau phase 2 of the ventricular action potential. The T wave is determined largely by ventricular repolarization (phase 3), while the isoelectric segment is the result of the electrically neutral phase 4 of the ventricular action potential.

AP morphologies are the result of the precise and carefully timed sequences of opening, closing, and inactivation of an array of membrane ion channels in response to cellular membrane potential changes, ligands that bind to the ion channel complex, or membrane stretch in a time-dependent fashion. The open ion channel allows flux of specific charged ions through a central pore, resulting in electrical (ionic) currents that drive the AP. The activity of different subsets of ion channels drives the different phases of the AP. Specific ionic currents that flux through an open channel are driven by the electrochemical gradient of that particular ion across the membrane, which in turn is driven by ion pumps or transporters/exchangers, which in turn are catalyzed by ATP (**Fig. 243-2**).