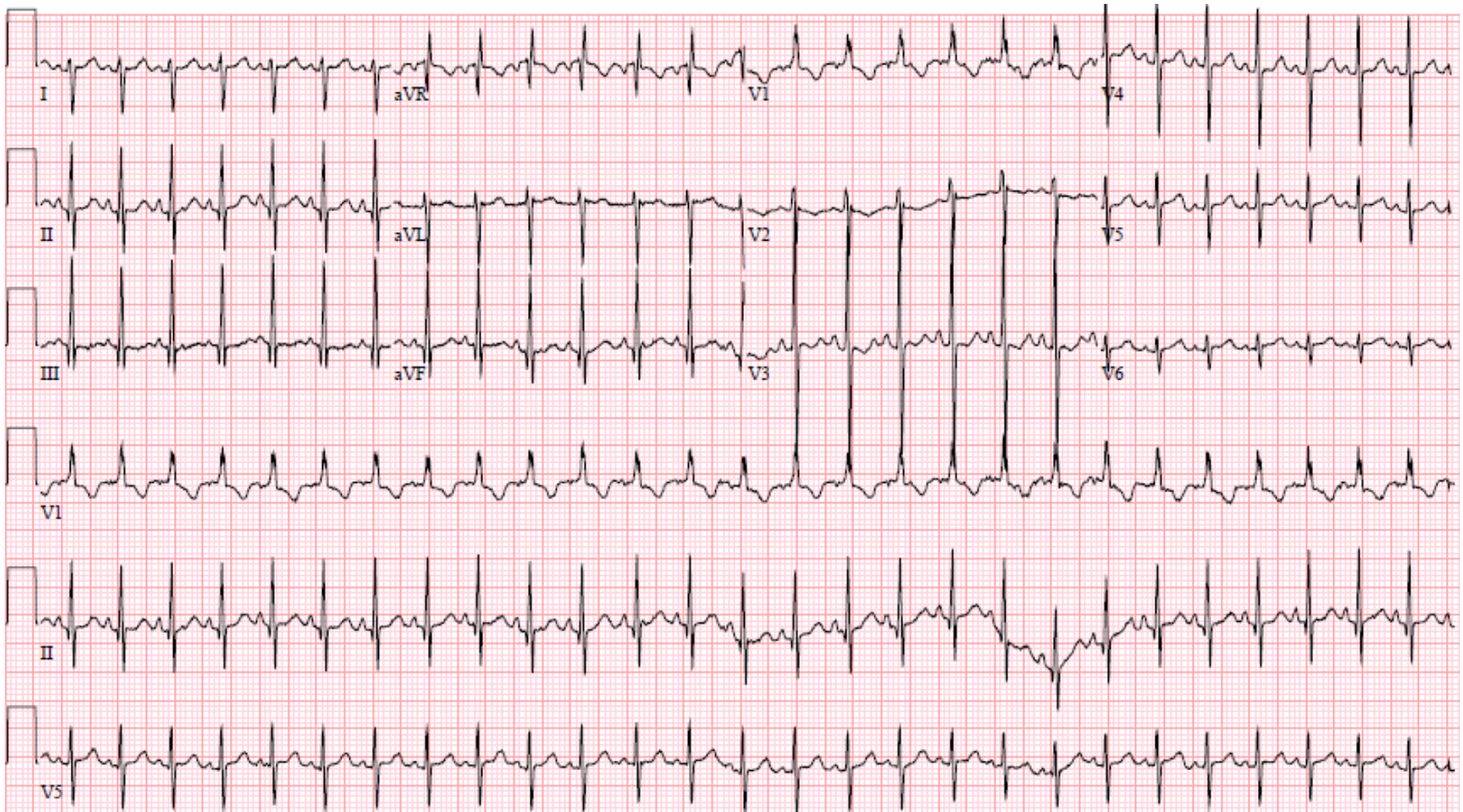
You are called to the nursery to review an ECG performed on a 5 day old infant.

1) Is this ECG normal or abnormal (1 point)?
2) Would your answer change if this was an ECG from a 17 year old teenager? Why (1 point)?
3) Physiologically, what explains the difference we see between typical newborn ECG's and those in older children (1 point)?



1) Is this ECG normal or abnormal (1 point)?

This is a perfectly normal ECG in a 5 day old infant. It displays normal sinus rhythm with normal P wave and QRS axes, normal intervals, and no evidence of atrial enlargement or voltage criteria for ventricular enlargement.

2) Would your answer change if this was an ECG from a 17 year old teenager? Why (1 point)?

Yes. Look at the QRS axis (*if you don't remember how to establish QRS axis, see below*). In a teenager, the QRS axis should be downward and toward the left. We will tolerate a slightly rightward axis as normal in a teen, but this ECG shows a QRS axis of about 130-140 degrees. A rightward axis in a newborn is normal (see #3).

3) Physiologically, what explains the difference we see between typical newborn ECG's and those in older children (1 point)?

Remember that in fetal life, shunting mainly via the ductus arteriosus results in the right ventricle (RV) providing about 2/3 of combined cardiac output. Newborn infants therefore have a relatively more massive RV as compared to LV. As a result, the electrical signal that is created by the right ventricular myocardium is also more massive than the electrical signal from the LV. All signals on an ECG are in reality the sum of many electric vectors, which each have a direction and an amplitude. The greater amplitude of the rightward forces in an infant "pulls" the QRS axis toward the right, and this is what we expect to see. As the child grows, the LV becomes the dominant ventricle, as it gets used to pumping against systemic vascular resistance and the RV gets "out of shape" pumping against the lower pulmonary vascular resistance. This usually occurs by around 2 months of life—and the QRS axis begins to swing toward the left. This process tends to continue through adolescence.

* Recall that we establish P wave and QRS axis in the frontal (coronal) plane by looking at these waves in leads I and aVF. Lead I is, by convention, straight to the patient's left (this is designated as zero degrees, again by convention). Lead aVF is straight down (by convention, at 90 degrees). When heart muscle depolarizes, a wavefront is created as that depolarization spreads through the myocardium. As the wavefront moves toward a particular lead, a positive deflection is seen. If the wavefront moves away from a lead, a negative signal is created. We expect the P wave to be upright in leads I and aVF as the atria depolarize from top right to bottom left. In an older child or adult, we expect the same pattern for the QRS. In a newborn infant, however, the QRS axis is usually downward and toward the right (see explanation for #3).