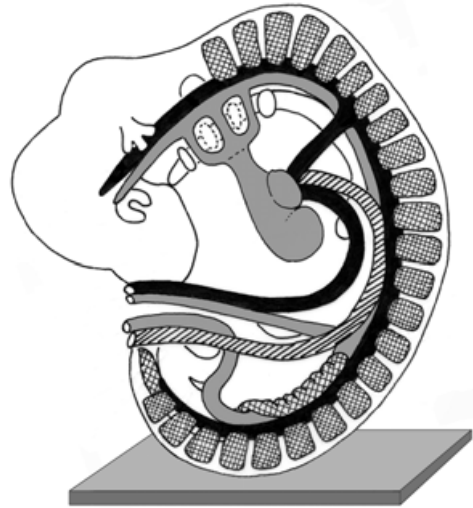


Modelling a One-Month Human Embryo

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Model-building is a great help in understanding the structure of human embryos. The process of construction focuses your attention on positional relationships, and once your hands have learned their way around the model your brain won't easily forget it. The model that you will construct if you follow these instructions represents a critical stage, four weeks after conception, when the rudiments of all the major organs are being laid down and a primitive blood circulatory system is fully established. Your model will be about twenty times life size; (the crown-rump length of a living embryo at this stage is about 4 mm).

You will need small quantities of a heat-curable modelling compound in six colours. Suitable materials include 'Du-kit'[™] and 'Fimo'[™], available in many craft stores. This material can be moulded and shaped with your fingers and remains pliable until heated to 125 °C for 15 minutes, when it hardens irreversibly. The model is colour-coded to indicate the germ layer of origin for organ rudiments, and the level of oxygenation of blood within blood vessels. The colours, and the amounts you will need, are:–

Organ rudiments

Ectoderm = flesh,	30gm
Mesoderm = light brown,	10gm
Endoderm = black,	5gm

Blood vessels

Highly oxygenated blood = red,	5gm
Moderately oxygenated blood = purple,	7gm
Poorly oxygenated blood = blue,	5gm

You could, of course, use other colours for ectoderm, mesoderm and endoderm; but the blood vessels must be the colours stated above. In case you do not have a balance for weighing small quantities, 30gm of modelling compound is a piece about the size of a golf ball.

You will need to print out this document on paper. Most of the drawings here are designed to print at exactly the same size as the model. As you form the pieces of the model, you can lay them on top of the drawings to check them for shape and size. In order to be sure that your printer is printing at the correct size, print this page and measure the length of the line below; it should be 50mm long on the printed page.



For background, you could read about the first month of embryonic development in one of the following, or an equivalent:–

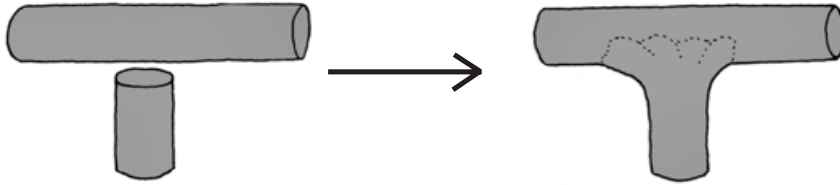
Cook & Osmond, *'The Embryonic Disk' CD-ROM*. Timetable for weeks 1–4 / Days 15–28.
Sadler, *"Langman's Medical Embryology"* Lippincott Williams & Wilkins 2000

Hints about using the modelling compound.

- 1 The compound is stiff at first, but will soften as you knead it with your hands. It can be shaped with your fingers, with any convenient tool, or rolled out into cylinders on a flat surface.
- 2 Light colours pick up dirt easily. When changing from a dark colour to a light one, it may be worth washing your hands in between to prevent particles of the dark colour from being

transferred from your fingers to the light colour.

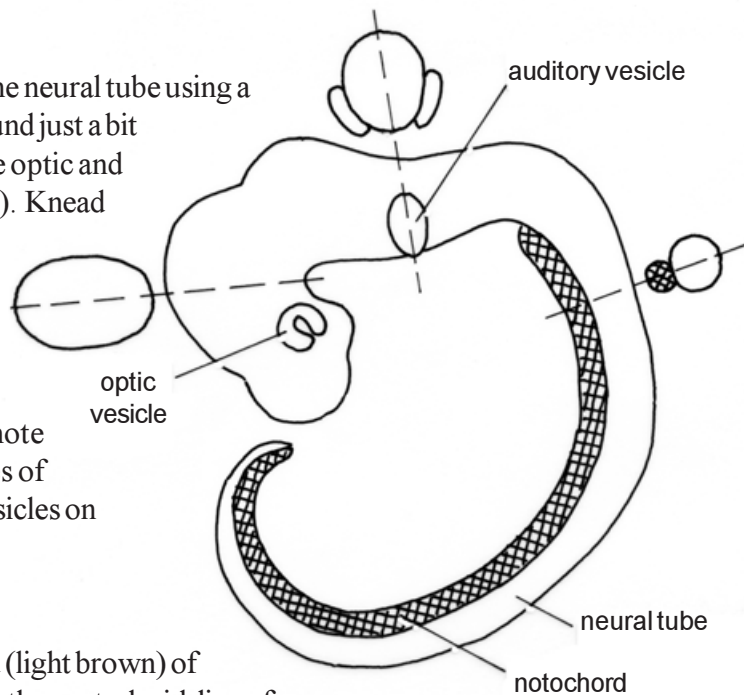
- 3 Pieces can be joined by pressing them firmly together. If the pieces are the same colour, an even stronger joint can be formed by blending the edges of one into the other using a small tool. We use a small metal dissecting probe with a spatulate end, but you could just as well use a matchstick with one end rounded and flattened using sandpaper.



- 4 The compound shrinks a little as it cures in the oven. Very slender pieces (e.g. pieces rolled out to form blood vessels thinner than a matchstick) may break because of shrinkage unless they are firmly supported by something more solid.

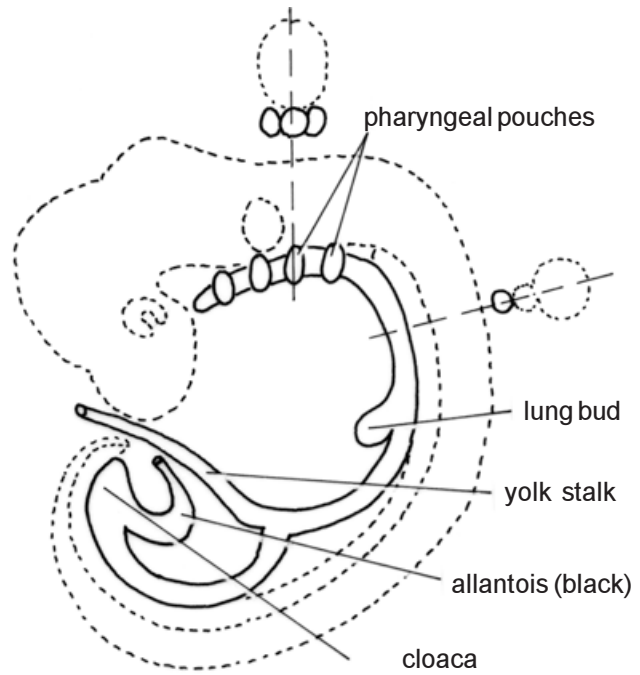
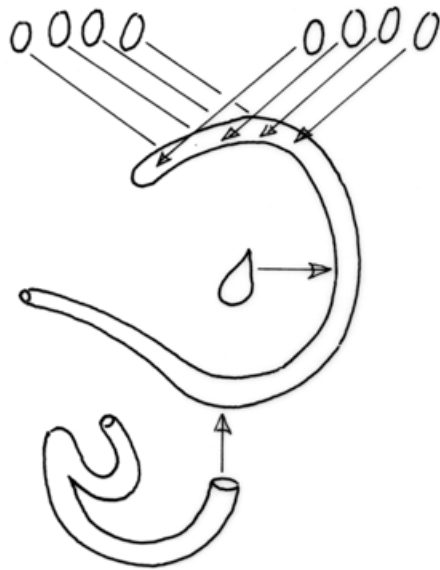
One-month human embryo

1. **Neural tube.** Begin by forming the neural tube using a piece of flesh-coloured modelling compound just a bit smaller than a golf ball, (save a little for the optic and auditory vesicles, and Trigeminal ganglion). Knead the compound into a ball in your hands until it is warm and soft, then roll it out into a cylinder wide at one end and narrow at the other. Bend the cylinder until it is about the same size and shape as the neural tube in the drawing; (note the three cross-sections). Use small pieces of flesh-colour to form optic and auditory vesicles on each side.

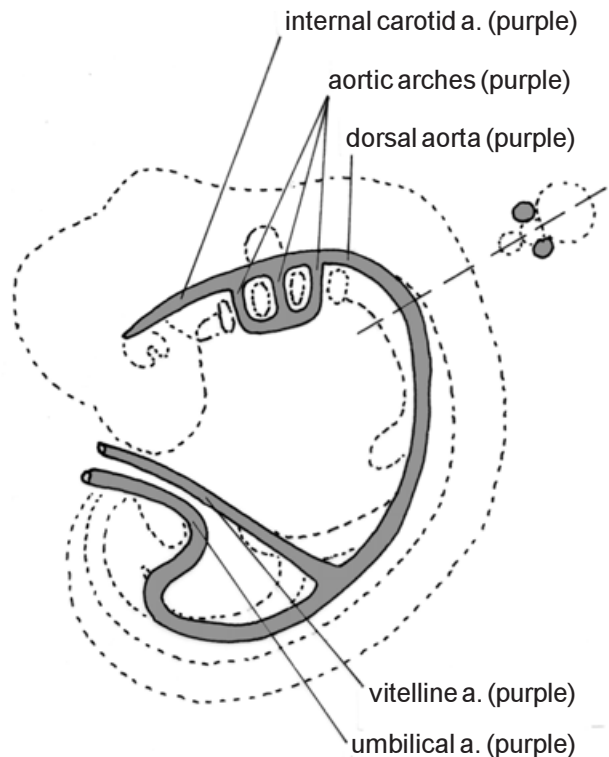
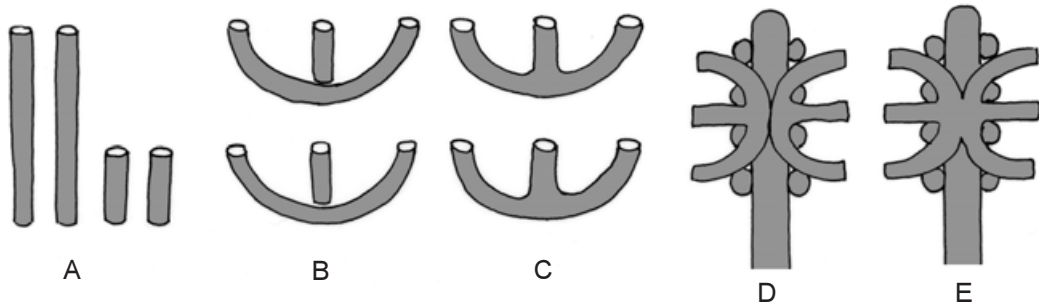


2. **Notochord.** Roll out a notochord (light brown) of uniform diameter and press it into place on the ventral mid-line of the neural tube (except in the brain region).

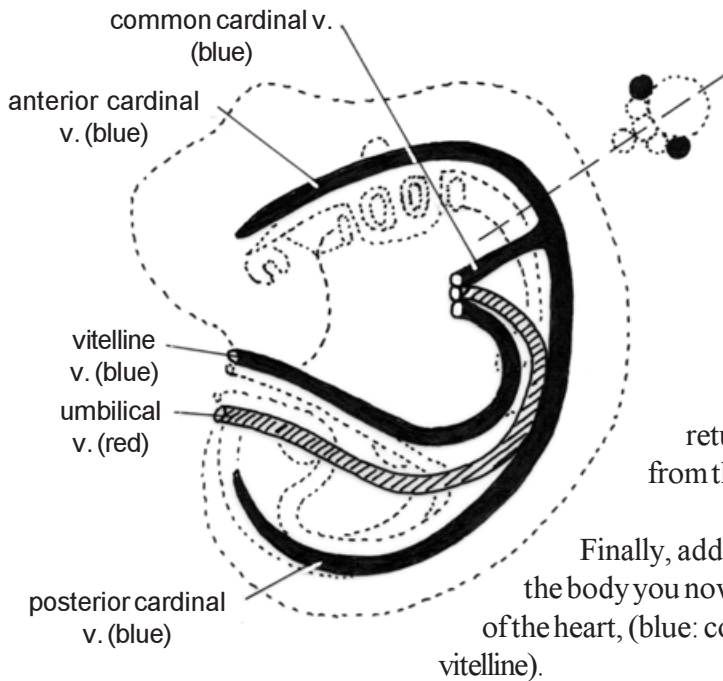
3. **Gut.** Form the gut (black), adding 4 pairs of small lumps (pharyngeal pouches) on each side near the anterior end, and three single extensions progressively further back as in the figure on the next page. The single outgrowths are the lung bud, yolk stalk and allantois. If you have difficulty understanding how the pharyngeal pouches could be represented as "lumps" on each side of the foregut, imagine that the black modelling compound represents a cast of the interior of the gut; (casts are usually made by pouring plaster or resin into a hollow organ and allowing the material to set). In that case any hollow pockets on the side of a tube would be represented by projections on the side of the cast.



4. **Arterial system.** Make the aortic arches (purple) by rolling out four small cylinders (A). Bend the longer pieces, (B). Join them as in (C). Lay them across the ventral side of the pharynx, placing them carefully in relation to the pharyngeal pouches (D). Join the left and right sides (E).



Now roll out four narrow cylinders (purple), two long ones for the dorsal aorta and umbilical artery on each side and two shorter ones for the vitelline arteries. Attach the dorsal aorta across the free ends of the aortic arches. All these vessels are shown in the diagram (right). Note that having two aortas all the way down is a slight simplification; in reality they join to form a narrow Y-shape, where the stem of the Y is a single midline abdominal aorta.







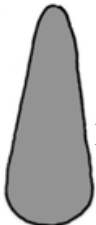
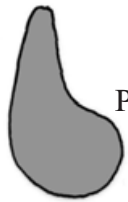
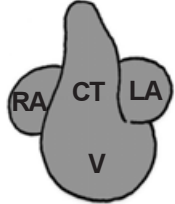
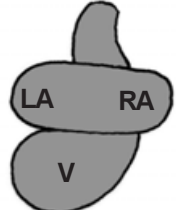
5. **Venous system.** Begin by installing the anterior and posterior cardinal veins (blue) each of which fits in one length beside the aorta. Attach the short common cardinal vein before installing all these veins on the model. The heart end of the common cardinal vein will remain unattached for now.

The umbilical veins are next. They are formed from red compound, since they are returning well-oxygenated blood to the heart from the placenta.

Finally, add the vitelline veins (blue). On each side of the body you now have three veins combining in the region of the heart, (blue: common cardinal, red: umbilical and blue: vitelline).

6. **Heart.** The heart must be constructed from purple compound, since it receives mixed blood.

For the atria, form a ball of purple compound this size:  Roll it out to a blunt sausage-shape:  Make a depression in one side: 

Form the ventricle and conotruncus from a ball of purple compound this size:  Roll it into an elongated pear shape:  Bend the pear-shape in the middle:  Press the two parts together:  The heart in ventral view comprises the right atrium (RA), left atrium (LA), primitive ventricle (V) and cono-truncus (CT). In dorsal view the two atria run transversely across the back of the heart:  On the dorsal side, push a shallow depression into

each atrium to receive three veins:



Now carefully fit the heart in place on

your model. This drawing shows how the heart will be attached to the aortic arches:

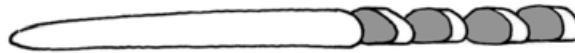


Three veins will enter each atrium,

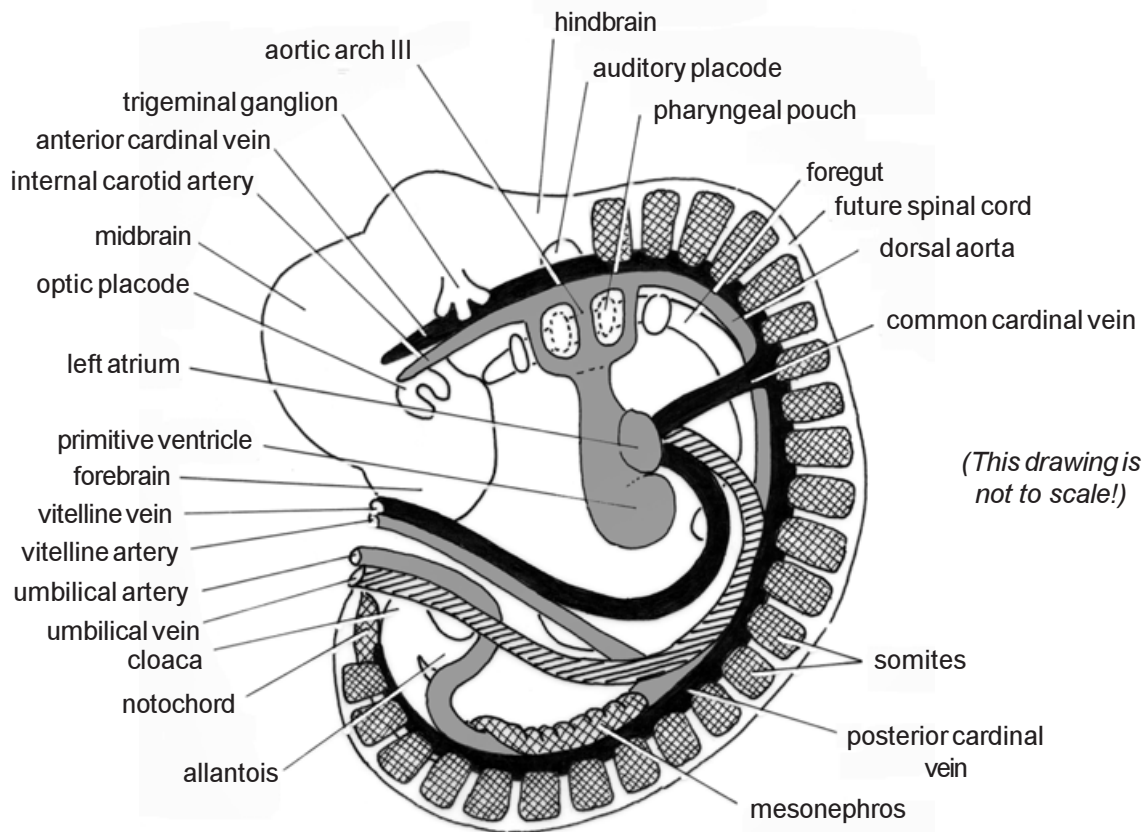
(squeeze their ends together first).



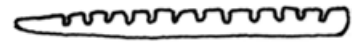
7. **Somites.** Roll out a cylinder of light brown compound about 10cm long. At one end it should be as thick as a pencil, at the other as thin as a matchstick. Flatten the cylinder somewhat. Use a knife to slice the strip into 3mm segments.



Press the segments into place on the lateral surface of the neural tube, slightly overlapping the cardinal veins. Repeat on the other side of the embryo. At the cranial end, begin fitting somites just below the level of the hindbrain; at the caudal end, finish at the tail. The number of somites shown in the diagram is arbitrary and slightly low; by this stage there should normally be 30-32 pairs, rising to 43 pairs on day 31.



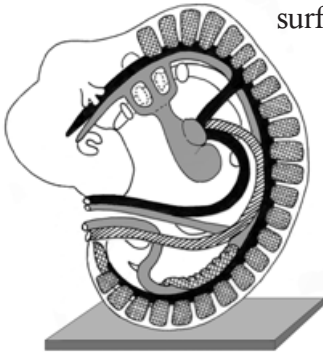
8. **Kidneys.** Embryos at this stage have the second of three successive sets of kidney systems (pronephros, mesonephros which we will fit, and metanephros which forms the adult kidneys). The mesonephroi are simple to make. On each side of the embryo roll out a small cylinder of light brown, attach it to the hind gut, and make repeated notches on one side of the cylinder. The raised bumps between the notches represent the renal corpuscles; the smooth part of the cylinder represents the mesonephric duct.



9. **Trigeminal ganglion.** This is the largest of the sensory ganglia on the lateral side of the hindbrain. Flatten two tiny pieces of flesh-coloured compound, indent them to form three blunt branches, and attach on both sides of the hindbrain.



10. **Heat-curing.** Place your finished model carefully on a sheet of smooth card. If you are working at home, heat your domestic oven to 125°C. Test that the oven temperature is correct by baking some spare modelling compound for 15 minutes before committing your embryo. If the oven temperature is too low the compound will not harden; if it is too high then the surface of the compound will become glazed and shiny with small white flecks.



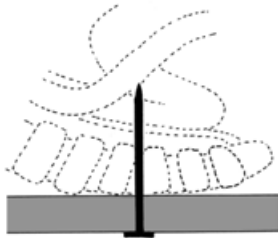
11. **Labels.** Cut them from the list below. They are best glued in place with white PVA glue.

**HUMAN EMBRYO (5th week)
Scale 20:1**

Neural tube Forebrain Midbrain Hindbrain Somite Foregut Lung bud Allantois Umbilical a.

Umbilical v. Vitelline a. Vitelline v. Yolk-stalk Ventricle Atrium Dorsal aorta Int. carotid a.

Com. cardinal v. Ant. cardinal v. Post cardinal v. Cloaca Notochord Mesonephros



12. **Mounting the model.** A piece of plywood, hardboard, or cork about 5cm square is suitable. From the under-side, drive a small nail through the centre. Drill a hole through the neural tube to accept the nail. Glue in place, (epoxy is good). If you don't fancy trying to dust all those cracks and crevices, cover the model with an inverted glass or clear plastic container.