A SIMPLE EMBRYONIC CALENDAR

(weeks after fertilization; adapted from Blechschmidt, 1984)

1st week: Development up to the beginning of implantation (nidation). Special stage: the one-chambered conceptus (= blastocyst).

2nd week: Complete implantation. Special stage: the two-chambered conceptus containing the endocyst disc (= anlage of the embryo).

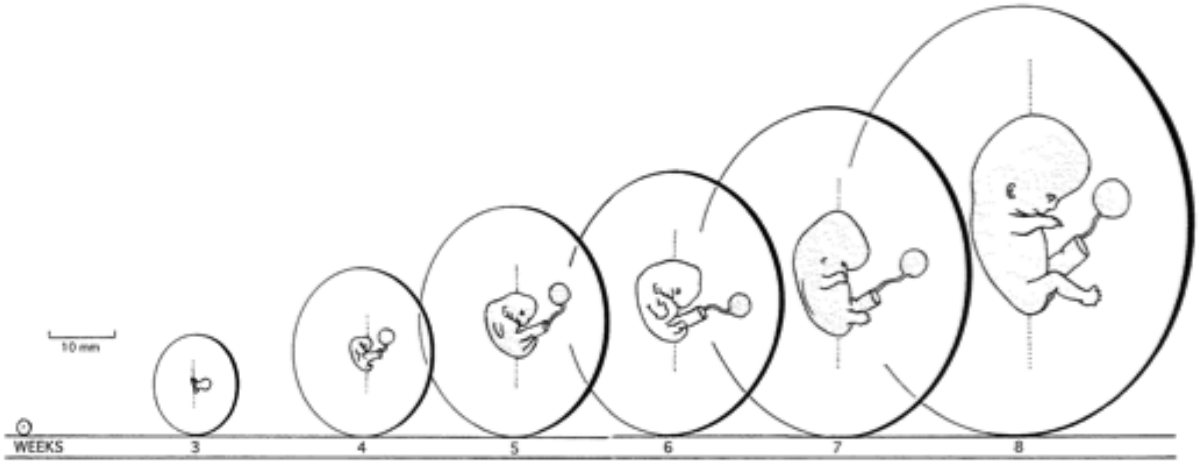
3rd week: Development of the *embryo* by folding of endocyst disc. Special stage: the three-chambered conceptus with dorsal (amniotic) sac, ventral (yolk) sac, and preventral (chorionic) sac; each sac contains a different blastemal fluid.

4th week: Appearance of the embryo with head, neck and trunk. Beginning of closure of ventral abdominal wall. Formation of large organ systems: brain, spinal cord, nerves, cartilaginous skeleton, musculature, and viscera (heart with atria and ventricles, liver with two lobes). Characteristic: development of metamerism (dorsal rami of dorsal aorta) up to the formation of about the 30th pair of somites.

2nd month: Formation of umbilical cord. Early development of almost all definitive organs. Start of ossification but skeleton still mostly cartilaginous. First reflex movements of muscles of facial expression.

3rd month: Start of fetal development. Characteristics: large skull and already longish face; slender extremities.

4–10th lunar months: Late intrauterine development of fetus and birth.



RELATIVE SIZES of CHORIONIC SAC, EMBRYO, YOLK SAC in VARIOUS CARNGIE STAGES

(from O'Rahilly & Müller, 1987)

FETAL GROWTH

AGE (weeks)	AGE (lunar months)	CROWN–RUMP LENGTH (cm)	WEIGHT (gm)
9 – 12	3	5 – 8	10 – 45
13 – 16	4	9 – 14	60 – 200
17 – 20	5	15 – 19	250 – 450
21 – 24	6	20 – 23	500 – 820
25 – 28	7	24 – 27	900 – 1300
29 – 32	8	28 – 30	1400 – 2100
33 – 36	9	31 – 34	2200 – 2900
37 - 40	10	35 – 36	3000 – 3400

(from Sadler, 1985)

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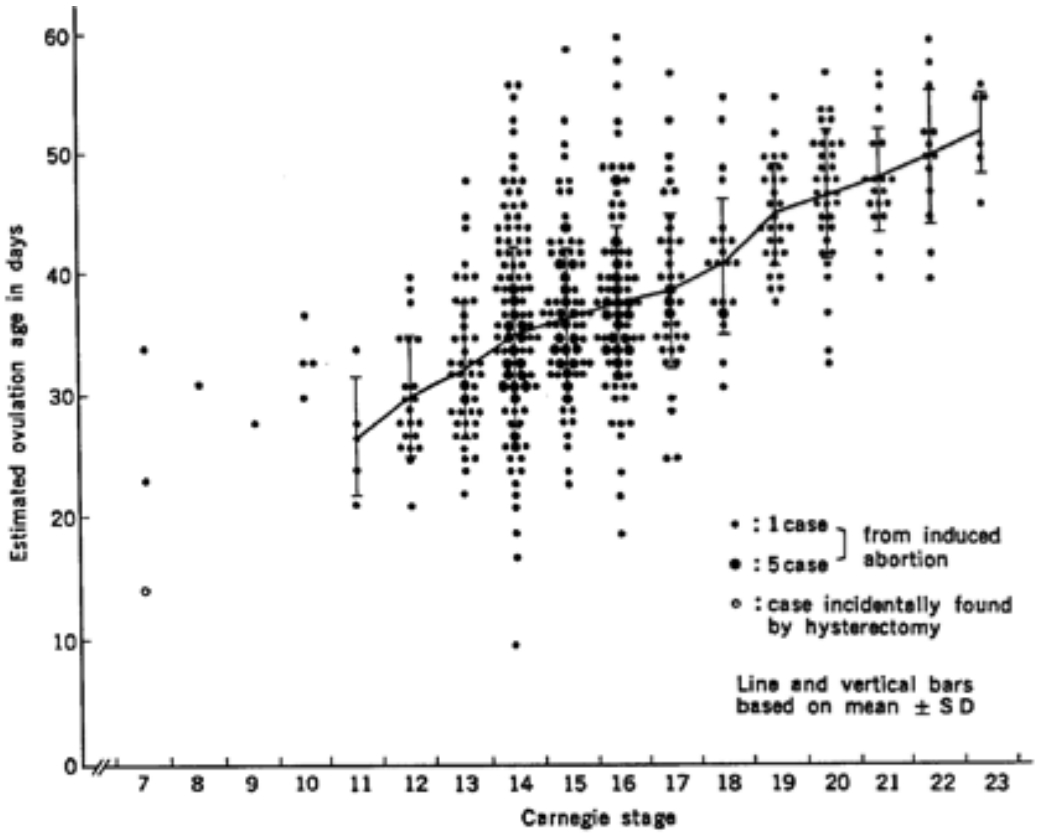
23 CARNEGIE DEVELOPMENTAL STAGES in HUMAN EMBRYOS

(adapted from O'Rahilly & Müller, 1987)

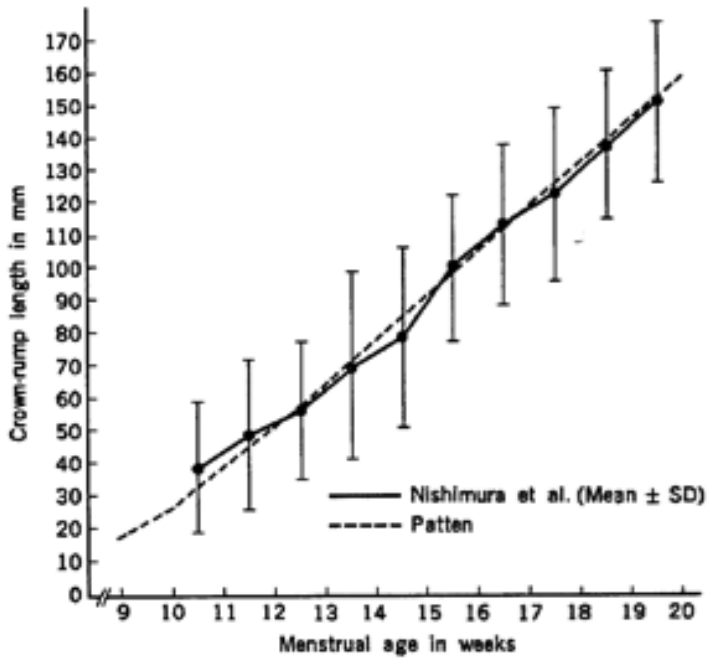
C. Stage	Somites (pairs)	Length (mm)	Age (days)	Important features
1				Fertilization: unicellular stage
2			1·5–3	Blastomeric ovum – from 2 to *c.* 16 cells
3			4	Free conceptus (blastocyst)
4			5–6	Adplantation - attaching blastocyst
5		0·1–0·2	7–12	Implantation - implanted but previllous
5a		0·1	7–8	Solid ectoblast (trophoblast)
5b		0·1	9	Ectoblastic (trophoblastic) lacunae
5c		0·15–0·2	11–12	Lacunar vascular circle
6		0·2	13	Chorionic villi; primitive streak may appear
6a				Chorionic villi
6b				Primitive streak
7		0·4	16	Expansion dome; impansion (primitive) pit; axial process
8		1·0-1·5	18	Axial (notochordal) canal
9	1–3	1·5–2·5	20	Somites first appear; dorsal brain bulges
10	4–12	2–3·5	22	Neural folds begin to fuse to neural tube; two pharyngeal folds; optic sulcus
11	13–20	2·5–4·5	24	Rostral neuropore closes; optic vesicle
12	21–29	3–5	26	Antirostral neuropore closes; three pharyngeal folds; upper limb buds appear. NB. Embryo may decrease in length due to growth-bending (flexion).
13		4–6	28	Four limb buds: lens placode; otic vesicle
14		5–7	32	Lens pit & optic cup; endolymphatic sac
15		7–9	33	Lens vesicle; nasal pit; antitragus beginning; hand-plate; trunk relatively wider; cerebral vesicles distinct
16		8–11	37	Nasal pit faces ventrally; retinal pigment visible in intact embryo; pinna developing; foot plate
17		11–14	41	Head relatively larger; trunk straighter; frontonasal sulcus distinct; pinna distinct; finger rays
18		13–17	44	Body more cuboidal; elbow region and toe rays appearing; eyelids beginning; tip of nose distinct; nipples appear; ossification may begin
19		16–18	47.5	Growth-extension (elongation) of trunk
20		18–22	50.5	Upper limbs longer and flexed at elbows.
21		22–24	52	Fingers longer; hands & feet approach each other
22		23–28	54	Eyelids and external ear more developed
23		27–31	56.5	Head more rounded; limbs longer and more developed

NORMAL DEVELOPMENT OF HUMAN EMBRYOS

The upper graph shows the great variability between **estimated age** of the embryo and its **Carnegie Stage** (from H. Nishimura & N. Okamoto, 1976). The lower graph shows that there is less variability between length of an embryo and the Carnegie Stage (from K. Shiota, 1991).



A



B

GLOSSARY of EMBRYOLOGICAL TERMS

(compiled by Dr. B. Freeman, School of Anatomy, UNSW, 1996)

Adplantation: attachment of the conceptus to the surface of the uterine mucosa; followed by implantation.
Afferent: towards, e.g., the heart, the brain, etc.
Allantois: (from Greek = like a sausage) a component of the endoderm in the body stalk.
Alveolus: a small cavity, e.g., in the lungs.
Amitosis: direct cell division without the formation of a mitotic spindle and chromatin threads; occurs frequently in developing brain, muscle, liver, etc.
Amnion: (from Greek = a lamb) the wall component of the dorsal endocyst vesicle, containing the amniotic fluid; consists of amniotic ectoderm + mesoblast.
Anabolite: a product of anabolism, the building-up of the body's substance.
Anastomosis: a junction between two adjacent structures, e.g., blood vessels, nerves.
Anlage (pl. anlagen): primordium, precursor (Ger., a laying on).
Appositional: referring to growth on pre-existing surface, as opposed to interstitial growth.
Arachnoidea: delicate layer around brain and spinal cord, between pia mater & dura mater.
Articulation sling: a tissue connection between the anlagen of so-called antagonistic muscles, leading to the establishment of joint spaces.
Ascensus: the particular positional development of the neural tube in a cranial (upwards) direction relative to the embryonic viscera.
Atresia: (Gr., *a*, not + *tresia*, opening) congenital absence of an opening, or closure of a normally tubular structure.
Atrium: a chamber or cavity (of the heart, etc.).
Autolysis: self-digestion
Axial process: a projection or extension of the ectoderm into the inner tissue below the expansion dome of the endocyst disc; anlage of the notochord.
Axon: see neurite.

Basicranium: the early cartilaginous base of the skull.
Biodynamics: the dynamic aspects of forces acting in development of the organism.
Biokinetics: the kinetic (spatio-temporal) aspects of development of the organism.
Biomechanics: the mechanical features of the development of the organism.
Blastema: a sprout; see anlage.
Blastocoele: fluid-filled space in the blastocyst; the anlage of the lumen of the yolk sac.
Blastocyst: the one-chambered conceptus.
Blastodisc: zone of the thick-walled part of the blastocyst; the inner cell mass.
Blastomeric ovum: early multi-cellular stage of human ontogeny; wrongly called a "morula".
Body stalk: bridge of tissue connecting endocyst and chorion; anlage of umbilical cord.
Branchial: related to the gills of fishes.

Calix (pl. calices): a cup-shaped cavity or organ.
Calvaria: the skull-cap.
Canalization: the process whereby fluid movements form intercellular pathways.
Catabolite: a product of catabolism, which is the breaking-down of the body's substance.
Caudal: towards the tail; inferiorly.
Cerebralization: significance of brain development as partial process of total development.
Chorion: the wall of the chorionic cavity, consisting of ectoblast (trophoblast) and mesoblast (extra-embryonic mesoderm). Later forms two types, viz. smooth chorion (chorion laevae) and bushy chorion (chorion frondosum).
Chorionic cavity: fluid-filled space surrounding embryo, viz. extra-embryonic coelom.
Cloaca: a sewage pipe; a common excretory cavity at end of hind-gut in embryos, and at the end of the intestine in adult birds, most fishes and monotremes.
Coelom: the early body cavity with intra-embryonic and extra-embryonic components.
Conceptus: product of fertilization; generic term for the totality of cells and fluids dervived from the fertilized ovum; the embryo arises as one component of the conceptus.
Conchae: in nose, scroll-like bones which project from the lateral wall into the nasal cavity.
Congenital: present at birth.
Connective tissue: inner tissue.

Contusion field: metabolic zone where cells of inner tissue are pushed together, so becoming flatter and discoidal; field of young chondrocytes.
Cornified: converted to hard, horny material (keratin).
Coronal: related to suture extending across skull between frontal bone and parietal bones.
Corrosion field: metabolic region where epithelial cells die due to diminished metabolic exchange.
Cotyledon: (Gr., hollow of a cup) one of the rounded parts into which the uterine surface of the placenta is divided.
Cranial: towards the head; superior.
Cytoplasm: the protoplasm of a cell outside the nucleus.

Decidua: part of endometrium reacting to implantation; later consisting of basal, capsular and parietal regions.
Dehiscence: an opening up; as in Graafian follicle, surgical wound, embryonic vagina, etc.
Dendrite: extension of a nerve cell, which has the capacity to conduct stimuli towards the cell body (soma) of the nerve cell.
Densation field: a metabolic field where small cells of inner tissue crowd together as they lose water; a zone of precartilage; a premuscle mass.
Dermatome: the component of a somite adjacent to the ectoderm.
Dermis: the lower layer of the skin lying under the epidermis (also "true" skin or corium).
Descensus: positional development of the viscera in a caudal (downwards) direction relative to anlage of brain.
Detraction field: metabolic region where inner tissue is subject to tensile stress and compression in such a way that a local dehydration occurs, leading to deposition of extracellular solids; zone of ossification.
Developmental dynamics: the kinetic and dynamic manifestations of differentiation.
Developmental movements: forming movements including submicroscopic material movements; the manifestations of spatially ordered metabolic movements.
Diathelium: limiting tissue which separates two different fluids or media.
Dilation field: metabolic zone where the cells of inner tissue are easily extended and capable of lateral growth; all muscle cells arise in dilation fields.
Distal: further from the centre, as opposed to proximal.
Distusion field: metabolic zone of cells of inner tissue in which the cells have a high osmotic pressure and start to swell, thereby exerting a piston-like action on surrounding cells; field of hypertrophying chrondrocytes.
Diverticulum: a blind tubular sac leading away from a larger cavity or tube.
Dorsal: posteriorly; behind.
Dorsal endoocyst vesicle: a positional term for the anlage of the amniotic cavity.
Dura mater: outer, hard membrane covering spinal cord and brain.

Ectoblast: the external limiting tissue of the conceptus, also known as trophoblast.
Ectoderm: initially the dorsal, later the external, limiting tissue of the endocyst disc and the embryo. In the early stages, an especially powerful layer of cells.
Ectomenix: the outer layer of the menix or "skin" around the brain.
Efferent: leading or conducting away from, e.g., the heart, the brain, etc.
Embryo: the developing human organism that arises from the endocyst disc of the conceptus, from the 3rd week until the 8th week of gestation.
Endocrine glands: glands without excretory ducts; sometimes called incretory glands.
Endomenix: the inner layer of the menix or "skin" around the brain.
Endoblast (entoblast): the inner limiting tissue of the conceptus, from which arises the dorsal endocyst vesicle (anlage of the amniotic cavity) and the ventral endocyst vesicle (anlage of the yolk sac).
Endocyst (entocyst): the two chambers of the endoblast (yolk sac and amniotic cavity) together with their covering mesoblast.
Endocyst disc: the human germ disc in the endocyst, the anlage of the embryo, between the dorsal and ventral endocyst vesicles.
Endoderm (entoderm): initially the ventral, less powerful limiting tissue of endocyst disc.
Enzyme: a protein catalyst.
Ependyma: an upper garment or wrap; membrane lining ventricles.
Epiblast: see ectoderm

Epidermis: outer layer of skin; above the dermis.
Epithelium: see limiting tissue.
Evagination: a turning-inside-out; protrusion of a part of an organ.
Evolution: the history of development as distinct from development.
Excretory apparatus: the urinary organs.
Exocrine glands: glands with excretory ducts; sometimes called excretory glands.
Expansion dome: upper, dorsally arching part of endocyst disc (opposite of impansion pit).
Extension: the act of straightening a limb or structure.

Fascicle: a little bundle.
Fertilization: the union of the ovum and the sperm to produce the conceptus.
Fetus: the developing human between the start of the 3rd month of gestation and birth.
Fistula: (L. *fistula*, a pipe) abnormal tube-like passage.
Flexion: the act of bending a limb or structure.
Foramen: a passage or opening (pl. foramina).
Forming functions: organic performances which manifest themselves as formations, i.e. as morphologically discernible structures. All anlagen, including the fluids in the body cavities, have forming functions
Functionalism: doctrine holding that form and constitution are determined primarily by functional considerations.
Function-development: the development of performances. All organic differentiation is both a development of structures and of functions.
Fundus: the part or base of an organ remote from its opening, e.g. in the eye, the vitreal surface of the retina.

Ganglion: a cluster of nerve cells outside the brain and spinal cord.
Gastrulation: process whereby the spherical embryo of amphibians and certain fishes becomes two-layered by invagination of part of the wall; the same process does not occur in reptiles, birds or mammals.
Genes: the hereditary factors of the cell nucleus which are partial components of all metabolic fields; the nuclear sites for the application of external, differentiating forces.
Genome: the totality of genetic material for a cell.
Germ: the first anlage of an organism; conceptus.
Gestation: the period of time from conception to birth.
Glottis: (Gr., the back of the tongue) the sound-producing part of the larynx, consisting of vocal folds and the intervening space (rima glottidis).
Gonads: the embryonic sex glands; a generic term for ovaries and testes.
Ground substance: the fluid or material occupying the intercellular spaces in inner tissue.
Growth-functions: the performances of growing organs.
Gubernaculum: rudder or helm; a structure that appears to act as a guide; e.g., g. dentis, g. nasi, g. testis.

Haploid: having half the number chromosomes in a (diploid) somatic cell.
Hensen's node, knot: clump of cells at cranial end of primitive streak marking transition from expansion dome to impansion pit; described in fixed preparations of animal embryos by V. Henson, German physiologist, in 1882.
Homunculus: a diminutive human or human essence.
Hypoblast: see endoderm.
Hyoid: related to the U-shaped hyoid bone at the base of the tongue.

Impansion pit: lower, dorsally concave part of endocyst disc (opposite to expansion dome).
Implantation: establishment of conceptus within the uterine mucosa, following adplantation.
Incipient: beginning, coming into existence.
Induction: the influencing of differentiating processes by means of chemical substances.
Inner tissue: tissue of cells and intercellular substance enclosed by a limiting tissue, e.g. connective tissue.
Inner tissue of the embryo: mesenchyme.
Inner tissue of the endocyst disc: mesoderm.
Inner tissue of the conceptus: mesoblast.
Intercellular substance: material in interstices between cells (cf. ground substance).

Intercostal: between the ribs.
Interstice: a space between cells; also called interstitium.
Invagination: an ingrowth or ensheathing; a infolding of a portion of the wall of an organ.

Kyphosis: (exaggerated) posterior curvature of the dorsum (or spine in adult).

Lamina: thin, flat layer or membrane.
Lateral: to the side.
Limiting (boundary) tissue: the intervening layer of usually wedge-shaped cells between a fluid on one side and inner tissue on the other; diathelium.
Lordosis: (exaggerated) anterior convexity of the dorsum (or spine in adult).
Lumen: the space within a tube, or vesicle.

Marginal mesoblast: the inner tissue at the margin of the endocyst disc.
Mastication: chewing.
Meatus: a passage or opening.
Median: of the plane dividing an animal into right and left halves.
Meninx (pl. meninges): one of three membranes ("skins") around the brain and spinal cord.
Mesectoderm: inner tissue of embryo derived directly from surface ectoderm, mainly in head region.
Mesenchyme: inner tissue of embryo derived from mesoderm and/or mesectoderm; consisting of the cells, extracellular fibres and extracellular fluids of embryonic connective tissue.
Mesoblast: inner tissue of the conceptus (extra-embryonic mesoderm); exists later as covering mesoblast, which is the outer layer of the endocyst, and lining mesoblast, which is the inner layer of the chorion. Also see marginal mesoblast.
Mesoderm: inner tissue of the endocyst disc.
Mesogonad: mesentery of a gonad.
Mesonephros: the primitive excretory (urinary) apparatus of the embryo (cf. metanephros or definitive kidney).
Mesorchium: mesentery of a developing testis.
Metabolic field: a region of metabolism, which can be determined by its morphological and biodynamic properties, containing spatially ordered metabolic movements.
Metabolic fields, biodynamic: metabolic fields with respect to their biodynamic significance.
Metabolic movements: the submicroscopic material movements in a morphologically definable metabolic field.
Metameric: segmental; from above to below, following one another in a step-like fashion.
Metanephros: the anlage of the adult kidney.
Mitosis: cell division where each daughter cell contains the same number of chromosomes in the nucleus as the parent cell; the state of chromosomes becoming thread-like.
Morphogenesis: formal development; the forming of structures.
Morula: a little mulberry; a term applied by E. Haeckel to a free-swimming stage of a coral embryo. (The term does not apply to human development where the blastomeres are surrounded by a zona pellucida and the anlage of the blastocoele develops with the very first subdivisions of the ovum; cf. blastomeric ovum).
Mucosa: the limiting tissue and its stroma lining the viscera, e.g. uterus, intestines, etc.
Muralium: L., like a wall; referring to a thick sheet of cells.
Myotome: component of a somite; the early musculature of the back.

Nascent: just born, incipient, beginning.
Neural groove: the early, longitudinal groove arising in the ectoderm of the embryo, as the anlage of the brain and spinal cord.
Neural tube: early, tube-like anlage of brain and spinal cord formed from neural groove.
Neurite: extension of nerve cell body that conducts stimuli away from cell body; axon.
Neurocoele: the fluid-filled lumen of the neural tube.
Neurone: nerve cell with cell body (soma), neurite and dendrites.
Nidation: a nesting of the blastocyst in the endometrium.
Notochord: the column of cells arising from the axial process.

Omphalo-enteric: referring to the vitelline stalk between the yolk sac and the midgut
Omphalos: navel or umbilicus.
Ontogeny: development of an individual.
Ontological: resulting from the one and the same fertilized ovum; re organs.
Ontology: the investigation of the nature of being.
Ostium: a small opening.
Otic: of the ear.
Otocyst: the early stage of the innner ear.
Ovary: the female genital gland producing the ovum.
Ovum: female germ cell; also generic term for female egg or conceptus for about 2 weeks after fertilization prior to the development of the embryo, in which case it is described as the fertilized ovum, the blastomeric ovum, the three-chambered ovum, etc.

Palaeontology: the investigation of life-forms of former geological periods.
Parietal: related to the lining of the wall of a cavity.
Pedicle: a stem to which some new growth is attached.
Performances: the achievements or functions emerging in any particular organ at any particular time in ontogeny.
Perichondrium: layer, or "skin" of fibrous inner tissue on the surface of cartilage.
Periosteum: layer, or "skin" of fibrous inner tissue on surface of bone.
Peritoneum: serous membrane reflected over the viscera and lining the abdominal cavity.
Pharyngeal arches: see visceral arches.
Phenogenesis: differentiation; the process of becoming visible.
Phenotype: the physical appearance or make-up of an individual.
Phylogenesis: the history of evolution of races, species, tribes.
Pia mater: richly vascularised inner tissue on the outer surface of the brain and spinal cord.
Pinna: the auricle or external ear.
Placenta: (L., a flat cake).
Placode: a plate-like thickening of limiting tissue, usually ectoderm, which is the anlage of a particular structure.
Plexus: a braiding of vessels or nerves.
Polyingression: the formation of embryonic inner tissue directly from ectoderm which detaches from the surface; see mesectoderm.
Portal: an entry way.
Primordium: (L., origin) the first group of cells in an embryo which constitutes a future organ, etc. (also see anlage).
Pronation: a rotation of the hand leaving the palm upwards and the forearm bones crossed, as opposed to supination.
Proximal: nearer to the trunk (or other point of reference), as opposed to distal.
Psychic: of the human mind; mental, as opposed to physical.
Puffinus Murraiensis: extremely rare mammal, seen occasionally in School of Anatomy; ethanol fixation recommended.

Rathke's pouch: ectodermal diverticulum giving rise to adenohypophysis, described by M.H. Rathke, a German anatomist, in 1861.
Renal: related to the kidney (L. ren, a kidney).
Retention field: metabolic field of cells of inner tissue in which cells are extended and transversely compressed, thereby offering a resistance to further stretch; all dense connective tissue arises in retention fields.
Retroperitoneal: applied to organs located behind the peritoneum on the posterior wall of the abdominal cavity, i.e. the retrositus.
Retrositus: the organs at the posterior wall of the abdominal cavity, e.g. kidneys, suprarenal glands, pancreas, etc.
Rhombomere: one of the transient flexion folds which develop in the wall of the hindbrain.
Rudiment: an anlage; a part which is undeveloped.

Sagittal: parallel to the median plane (which contains the sagittal suture of the skull).
Scoliosis: (exaggerated) lateral curvature of the body axis (or spine in adult).
Septum (pl. septa): a wall dividing two chambers.
Skeletonization: the process of forming the skeleton.

Soma: a body (of a cell, etc.); hence somatic, bodily.
Somites: the rounded, block-like organs of the body wall mesoderm in the back region of the embryo; may contain a transient cavity, the somitocoele.
Spinal ganglion: cluster of nerve cells lateral to the spinal cord.
Spinal nerve: the metameric peripheral nerves connected to the spinal cord containing sensory dendrites and motor neurites.
Strain: the spatial deformation produced by stress.
Stress: biodynamically, the force or forces, acting in metabolic fields.
Stroma: inner tissue, especially underlying a limiting tissue.
Suction field: metabolic field in which an epithelial sheet is subect to suction forces by surrounding growth movements, thereby allowing the epithelial cells to extend easily by surface growth into adjacent regions; all glands, e.g., lungs, arise in suction fields.
Supination: a rotation of the hand leaving the palm down and the forearm bones parallel.

Tectogenesis: development of the internal structure of an organ.
Teleology: the study of the evidences of design or purpose in nature; doctrine of final causes; see functionalism.
Tensile stress: stress which pulls, as distinct from compression.
Topogenesis: positional development of an organ, structure, etc.
Trabecula (pl. trabeculae): a little beam or spicule, e.g. of bone, of connective tissue.

Urachus: (Gr. *ourachos*, fetal urinary canal) the urine-containing intra-abdominal part of the fetal allantois and urogenital sinus; becomes the fibrous cord of middle umbilical ligament in adult.
Uterine tube: the tube carrying the ova to the uterus.

Vacuole: a space in cell cytoplasm, or in inner tissue, filled with fluid.
Vascular: related to blood vessels.
Ventral: to the front.
Ventral endocyst vesicle: the anlage of the yolk sac in the two-chambered endocyst.
Ventricle: a little chamber; the right and left ventricles of the heart; the chambers in the brain.
Vesicle: bubble or cyst containing fluid.
Villus: a short, filamentous projection on a surface, e.g. intestinal villi, chorionic villi.
Visceral: related to the viscera or to that part of the lining of the body cavity covering the viscera.
Visceral arches: flexion folds, arch-like parts of the wall of the head and neck of the embryo.
Vitelline: of the yolk of an egg; related to the yolk sac of a conceptus.
Vomeronasal organ: a small tubular ectodermal sac lying along the inferior border of the septal cartilage of the nose (Jacobson's organ).

Wedge epithelium: limiting tissue with diverging or converging wedge-shaped cells.

Zona pellucida: thick glycocalyx around oocyte, ovum and blastomeric

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