Developmental Process	NF stage number	NF stage name	LANDMARKS		
			EXTERNAL	INTERNAL	MOLECULAR MARKERS [*gene*: anatomy]
FERTILIZATION	n/a	mature egg	1 cell; ovulated unfertilized egg; animal hemisphere dark, vegetal hemisphere light; animal-vegetal axis in random orientation; soft texture	large nucleus, 'germinal vesicle' in animal hemisphere	***nanos1****:* mitochondrial cloud; ***vegt****:* vegetal cortex
	1	1-cell, fertilized egg	1 cell; vitelline membrane swells; eggs rotate with dark animal hemisphere up, light vegetal hemisphere down; firm texture; sperm entry point indictated by pigment condensation; germinal vesicle breakdown leaving pale spot in animal hemisphere	cleavage has not begun; germinal vesicle breaks down and pronuclei fuse; visible cortical layer thickest on animal and dorsal sides.	
CLEAVAGE	2-		first cleavage begins as a top to down furrow in animal hemisphere	cleavage furrow has not yet reached the vegetal pole	
	2	2-cell	2 cells; 1st cleavage plane is meridional along the dorso-ventral plane dividing right and left halfs		***sox3***, ***atp4a****:* animal hemisphere; ***vegt****:* vegetal hemisphere
	3	4-cell	4 cells; 2nd cleavage is meridional, perpendicular to the 1st cleavage; in many embryos, the 2 dorsal blastomeres (left and right) are smaller and lighter (on animal surface) than 2 larger darker ventral blastomeres (also left and right)[1]	cleavage cavity present	
					center
	4	8-cell	8 cells; 3rd cleavage plane is equatorial giving 4 smaller animal blastomeres (micromeres) and 4 larger vegetal blastomeres (macromeres); animal dorsal cells are lighter and ventral cells are darker in some embryos		***nanos1****:* germ plasm***; hwa****:* dorsal Wnt signalling
	5	16-cell	16 cells; 4th cleavage is again meridional; animal blastomeres smaller than vegetal blastomeres; dorsal blastomeres lighter than ventral.		
	6	32-cell	32 cells; 5th cleavage equatorial, giving 4 rows each with 8 blastomeres; animal pole with smallest rosette of micromeres, 2 middle rows of irregular shaped cels, larger vegetal rosette of macromeres		
	6.5	morula	64 cells; 6th cleavage; cleavages becomming asynchronous; animal/dorsal blastomeres divide before vegetal blastomeres		***gdf1****: vegetal hemisphere*; ***shroom1***, ***tfap2a****: animal hemisphere*
BLASTULA	7	early blastula	128-512 cells; 7th-9th cleavages, no longer possible to count cells reliably; size of animal cells used to distinguish embryo stage	clear delineation of the 3 primary germ layer tissues; notochord begins to form from mediolateral convergence of dorsal presumptive axial mesoderm under the neural ectoderm	***nodal5 (nr5)****:* earliest zygotic transcription
	8	middle blastula	~1000-4000 cells; 10-12+ cleavages; cell number no longer a stage guide; animal hemisphere with small dark pigmented cells refered to as 'animal cap'; animal surface looks 'pebbly'	at NF stage 8.5, after 12th cell divisions the mid-blastula transition (MBT) occurs; asynchronous internal cell division; zygotic genome activation	***gs17***, ***nr1:*** major initiation of zygotic transcription
	9	late blastula	animal hemisphere still darkly pigmented; animal surface more like 'grains of sand' than 'pebbles' of NF stage 8	blastocoel now maximum size; 3 germ layers becoming distinct; ectoderm in the animal 1/3 of the embryo, a ring of mesoderm in the middle and yolky endoderm on the vegetal 1/3	***sox17a****:* endoderm*; **tbxt**:* mesoderm
GASTRULATION	10	initial gastrula	darker pigment from bottle cells on the dorsal vegetal surface indicate dorsal blastopore lip formation, between '11 & 1 o'clock'; blastopore groove where cell ingress, is not yet visible	initial formation of Spemann Organizer at the dorsal marginal zone/upper blaspore lip	***gsc****:* upper blastopore lip; ***tbxt****:* marginal zone
	10.25	early gastrula	blastopore lip extends laterally ~1/4 around the circumference, from ~ '10 to 2 o'clock' ; indentation of blastopore visible as a groove	marginal zone involutes on dorsal side; internally, dorsal endomesoderm begins to migrate anteriorly along bastocoel surface; vegetal rotation of endoderm mass	
	10.5	crescent-shaped blastopore	arch of pigmented blastpore lip extends laterally from doral to lateral sides ~1/4 to 1/2 around the circumference; yolk plug almost round	medial-lateral intercalation of dorsal mesoderm; 'Brachet's cleft' forms between internal leading edge endomesoderm and the dorsal mesoderm; neural induction begins, dorsal-ventral patterning	***chrd.1***, ***lhx1****:* involuted dorsal mesoderm*; **ventx2.1**, **wnt8a**:* ventro-lateral marginal zone*; **hhex**:* anterior endomesoderm
	11	horse-shoe shaped blastopore	pigmented blastopore lip ~ half the circumference, pigmented bottle cells extend to the ventral side; yolk plug ~1/2 diameter of embryo, is slightly elongated in the dorsal-ventral direction	Brachet's cleft begins to open forming the archenteron; ectoderm, mesoderm and endoderm germ layers specified; blastocoel becoming smaller, mesodermal mantle undergoes convergent extension and endoderm is internalized	***sox17a****:* endoderm*; **tbxt**:* mesoderm*; **sox2**:* neurectoderm*; **krt12.4**:* non-neural ectoderm
	11.5	large yolk plug	blastopore lip extends all the way around yolk plug; lower/ventral blastopore lip more darkly pigmented; yolk plug not quite round, ~1/3 of embryo diameter elongated in the dorsal-ventral direction	blastocoel displaced to the ventral side; involuting 'endomesoderm' mantle continues to extent anteriorly	
NEURULATION	12	medium yolk plug	areas of light and dark pigment radiating from yolk plug (flower petal like); yolk plug small and circular, a little less than 1/4 of egg diameter, diameter decreasing; neurectoderm transforming into the discernible neural plate	blastocoel begining to close as the archenteron expands	***sox2***, ***sox3****:* neural plate
	12.5	small yolk plug	darker pigment lines on dorsal surface indicate future neural groove and neural plate; blastopore slit is slightly open, diameter decreasing and oval shaped	clear delineation of the 3 primary germ layer tissues; notochord forms from mediolateral convergence of dorsal axial mesoderm under the neural ectoderm	***chrd.1***, ***nog***, ***shh****:* axial mesoderm, notochord
	13	slit blastopore	blastopore completely closed to a 'slit'; neural plate on dorsal side clearly outlined	neural crest form at the neural plate border, i.e., the boundary between the neural and non-neural ectoderm	***sox2***, ***sox3****:* neural plate*; **ednra**, **msx1**:* neural plate border*; **snail2**;* neural crest*; **tbx2**:* cement gland primordium*; **myf5**:* paraxial mesoderm*; **rax**:* optic field
	13.5	initial neural plate	sharp demarcation of anterior neural plate; anterior aspect of neural plate bent down; yolk plug internalized		***tubb2b****:* differentating neural progenitors*; **msx1**:* anterior neural plate border
	14	neural plate	neural plate obvious; dorsal midline thin with neural folds thickening anteriorly and laterally; neural folds begin to elevate; convergence extension begins to narrow neural plate posteriorly	blastocoel continues to close in the ventral foregut region as archenteron expands on the internal dorsal side	***pax6****:* optic field, neural plate, lens placode; ***pax2****:* between anterior and posterior neural plate
	15	early neural fold	neural folds distinct; anterior neural fold round; demarcation of neural plate clear caudally, narrowing in middle and caudal regions; neural groove deepens; pigmented cement gland primordium faintly visible at the ventral-anterior border of neural plate, cells stand out from epithelial layer.	physical segregation of cranial neural crest from anterior (pre-chordal) neural plate; blastocoel closes in the ventral foregut	***pax3****:* neural fold/neural crest; ***pax8****:* intermediate mesoderm; ***rax***, ***otx2***, ***six3****:* optic field; ***hhex****:* foregut endoderm
	16	mid-neural fold	eye primordia [2] become discernable as indentations near the lateral edges of the anterior neural plate; anterior neural plate 'rectangular' in shape; neural plate sharply constricted in the middle.	right and left cardiac mesoderm migrates to anterior-ventral midline; foregut diverticulum forms	***pax6****:* optic field, anterior neural plate, and lens placode; ***nkx2-5***: cardiac progenitors; ***krt12.4****:* ectoderm, non-neural ectoderm, epidermis
	17	late neural fold	anterior neural plate oblong, triangular, angles formed by eye primordia [2]; clear neurenteric canal along midline, posterior end of which continues over closed blastopore slit; neural folds closing in trunk region	delineation of cranial neural crest lateral to the anterior neural plate; 1st indication of somite segregation from presomitic mesoderm	***sox2***, ***sox3****:* neural plate/neurenteric canal*; **otx2**, **rax**, **pax6**, **six1**, **sox2**:* optic field; ***lhx1****:* intermediate mesoderm
	18	neural groove	anterior part of neural plate narrow, club shaped; parallel neural folds very close but not touching	neural crest segregation begins; 3-4 anterior somites segregate from paraxial mesoderm	***myod1****:* early somites and presomitic mesoderm*; **casz**:* early somites; ***snai1***, ***egr2***, ***twist1****:* neural crest; ***pax8****:* otic placode.
	19	initial neural tube	neural folds moslty closed forming a neural tube, except for an open slit in the anterior neural plate; neurenteric canal deepening; dark pigmented cement gland primordium immediately ventral to anterior neural plate; laterla view of embryo convex oval, not elongated	migration of 4 neural crest streams begins; 4-6 anterior somites segregated	***ag1***, ***agr2****:* cement gland primordium

20	fused neural tube	neural tube fused anteriorly; no pharyngeal bulge visible; dark oval cement gland primordium below border of anterior neural plate; embryo starts to elongate; optic cup (eye primordium) forms; oral evagination (mouth) visible	neural crest extends to front to eye; paired glomus primordia present [2] ; anterior 6-7 somites; thickening of cardiac mesoderm		***rax***, ***pax6***, ***otx2***, ***six3:*** optic vesicle; ***wt1***, ***rgn:*** glomus; ***nkx2-5:*** cardiac progenitor cells; ***egr2:*** rhombomeres R3, R5, and neural crest; ***en2:*** midbrain-hindbrain boundary; ***snai2***: neural crest; ***chrd.1***, ***nog***, ***ssh:*** notochord
21	neural tube	embryo has a dorsal curvature, with flat ventral surface; one pharyngeal arch bulge; neural tube completely closed; optic vesicle ('eyes') begin protuding, forming 2 oblique 'oval spots'; multiciliated cells form on the surface of the epidermis	8-9 somites; first indication of pronephric mesenchyme; otic placodes form posterior to optic vesicle		***pax8***, ***lim1***: pronephric mesenchyme***;*** ***nrp1:*** neural tube; ***pax3***: hatching gland; ***tuba4b***, ***cfap206***, ***foxj1***: multiciliated epidermal cell
22	early tailbud	embryo begins to elongate (convergent extension); ventral surface slightly concaved; two pharyngeal arch bulges; distinct eye protrusion; anal opening displaced to ventral side	9-10 somites; ventral blood island forms; segreation of forebrain, midbrain and hindbrain		***gsx1***, ***sox3:*** brain segments***;*** ***gata1***, ***hba3***, ***tal1***: ventral blood island; ***nodal1***: lateral plate mesoderm on the left side only; ***tbx6***, ***foxd4l1.1***: early tail bud
		EXTERNAL	**INTERNAL**	**BEHAVIOR & PHYSIOLOGY**	**MOLECULAR MARKERS**
23	early tailbud	ventral surface concave giving embryo a 'coffee bean' look; two pharyngeal arch bulges; olfactory placodes thicken between eyes; slight depression of otic placode; jaw and gills separated by groove; "inverted Y shaped" hatching gland between eyes to cement gland	12 somites; forebrain regions telencephalon and diencephalon distinguishable		***cxcl14***, ***astl3a.1***, ***pax3:*** hatching gland; ***myod1:*** somites and presomitic mesoderm; ***six1:*** olfactory placode; ***pax2***, ***pax6***, ***vax2***: diencephalon***;*** ***foxg1:*** telencephalon
24	early tailbud	noticable elongation of the embryo and tail bud outgrowth; in dorsal view, eyes protruding out laterally less than gills; gill primordium area smooth (ungrooved)	15 somites; primary germ cells detecable in cell trunk endoderm; primary and secondary heart fields indictated in heart primordium	initial motor reactions to external stimuli	***tbxt***, ***lmo2***, ***aplnr***: tail bud; ***tnni3***, ***nkx2-5:*** primary heart field; ***bmp4:*** secondary heart field; ***grip2***, ***pgat:*** primordial germ cells; ***pcdh8.2:*** otic vesicle and tail bud; ***eya2:*** otic vesicle
25	early tailbud	embryo still convex dorsally and concave ventrally; eyes protruding out laterally equal to or more than gills, gills now grooved; otic vesicle pigmented	16 somites; head somite 1 diminished; brain flexure ~90o	multi-cilliated cells in the epidermis become active	***ag1***: cement gland***;*** ***tubb2b:*** brain and spinal cord
26	tailbud	If liberated from the vitelline membrane the embryo is straight, not convex dorsally; if the embryo remains in the vitelline membrane it is curved laterally; tail bud obvious; otic (ear) vesicle protruding	17 somites; head somite I disintegrated; pronephros distinct; myotomes distinct	spontaneous movements begin	***pax8***, ***hnf1b***, ***irx3***: pronephric mesenchyme
27	tailbud	tail bud defined in lateral view; fin translucent; lens begins to form, eyes flatten laterally; otic vesicle closes	heart fields merge forming a triangular-shape at ventral midline, behind the cement gland primordium and anterior to liver diverticulum; 19 somites		***pax6***, ***sox3***, ***prox1***, ***foxe3***, ***nrl:*** lens; ***neurod1***, ***sox3***: epibranchial placodes
28	tailbud	tail bud elongates distally and extends downward to cloaca; fin divided into outer transparent (outer fin) and inner translucent bands (inner fin); black cement gland fully formed; otic vesicle separates from epidermis	heart primordium and pericardial cavity discernible; pronephric nephrostomes form; 20-22 somites; epibranchial placodes first segregate	embryos liberated from the vitelline membrane glide around due to multi-cilliated cell fluid flow	***hand2***, ***actc1***: endocardial tube; ***dlx2***, ***sox9***, ***sox10:*** cranial neural crest; ***pax2***, ***lhx1***: nephrostomes; ***neurog2***, ***eya1:*** epibranchial placodes; ***fgf8***, ***sox9***: otic vesicle
29 & 30	late tailbud	tail bud distinct; outer fin edge transparent over entire length; gray disc of the eye cup now visible	23-25 somites segregated to end of tail; lumen in pronephric kidney collecting duct; appearance of glomus and thyroid; neural tube closure has formed the spinal cord		***runx1***: olfactory placode; ***lhx9:*** brain segments; ***foxa2***, ***tubb2b***: spinal cord; ***nphs1***, ***wt1:*** glomus; ***nkx2-1***: thyroid primordium***;*** ***not:*** tail tip
31	late tailbud	tail bud equal in length and height; nasal/olfactory pits first indicated	heart primordium extends ventrally and bends slightly to right; 22-23 post-otic somites; midbrain-hindbrain boundary distinct		***hey1***, ***myod1***, ***actc1***: somites; ***en2***, ***pax2***, ***fgf8:*** midbrain-hindbrain boundary
32	late tailbud	tail bud ~1.5x longer than height; eye cup distinct, U-shaped (open); mouth primordium not visible	heart a linear tube with anterior outflow tract, left ventricle, atrioventricular canal and atrium; 26 post-otic somites; pronephric nephrostomes form; lung buds visible		***pax2***, ***vax1:*** optic stalk; ***cfap161:*** nephrostomes and multiciliated epidermal cells; ***nkx2-1***: lung and thyroid progenitors***;*** ***aldh1a3***, ***agr2:*** otic vesicle
33 & 34	late tailbud	tail bud ~2x longer than height; gut ~3 x longer than tail; eye cup open C-shape with darker pigmentation dorsally; mouth primordium a shallow vertical groove; 32 post-otic somites; pigmented cells (melanophores) first appear on head (near hindbrain) and anterior trunk (near pronephric kidney)	heart looping begins; heart beat clearly observable; foregut begin to constrict at trachea-eophagus boundary; cranial nerves distinct; thyroid primordium discernible [2]; pronephric kidney and duct formed with surrounding vasculature; thyroid primordium detectable		***dab2:*** pronephric sinus, posterior cardinal vein; ***sox2:*** dorsal foregut; ***tubb2b***: cranial nerves; ***myl2***, ***bves:*** heart; ***actc1***, ***mybpc3:*** heart and somites; ***pax2***, ***lhx1***: pronephric kidney and pronephric nephrostomes [2]
35 & 36	free swimming tadpole [3]	tail bud ~3x longer than height; gut ~2 x longer than tail; outline of the proctodeum still curved; optic vesicle/retina completely black, choroidal fissure open; cardiac mesoderm starts to spontaneously contract; mouth invagination not quite round; 2 gill lobes; 36 post-otic somites; melanophores extend over top of head and along dorsal trunk	heart S-shaped, with distinct atrium lying dorsal to ventricle; vasculature to head and tail developing; liver bud visible posterior to heart; pronephric duct fused with rectal diverticulum, pronephric nephrostomes obvious	embryos naturally hatch from vitelline membrane to become free swimming	***aplnr***, ***hbz:*** blood vessels and heart; ***onecut***, ***nr1h5***, ***hhex:*** liver; ***aldh1a1:*** pronephric kidney/duct, choroidal fissure and olfactory bulb; ***tal1***, ***hba3:*** ventral blood island; ***nkx3.2:*** mouth primordium
37 & 38	free swimming tadpole	gut almost same length as tail; eye's choroid fissure closing ventrally but remain open; mouth invagination deep, round-shaped; heart contractions obvious, blood flow visible; proctodeum at obtuse angle (~140 degrees) to tail somites; 40 post-otic somites; melanophores extend over tail	paired lymph hearts; entire pronephric kidney functioning; ventral bud of pancreas formed;		***tnni3:*** heart***;*** ***sftpc***: lung buds; ***myh6***: lymph heart; ***atp1a1:*** pronephric kidney and pronephric duct; ***nkx2-1:*** thyroid and lungs; ***foxe3***: thyroid and lens; ***ptf1a***, ***pdia2:*** pancreatic buds
39	free swimming tadpole	gut equal in length to tail somites; melanophores around nasal pits & along ventral edge of tail somites; ventral choroid fissure nearly closed; proctodeum at ~125 degree angle to tail somites; 43 post-otic somites	retinal ganglion cell axons reach optic tectum; mesonephric kidney begins to form		***bmp4***, ***hoxa13:*** proctodeum; ***map2***, ***pou4f1;*** retinal ganglion cell layer; ***insm1***, ***nos1:*** optic tectum
40	free swimming tadpole	tail now longer than the abdomin; optic choroid fissure completely closed; mouth opening 'breaks through'; stomach and pancreas visible on the left side of gut; proctodeum at 90 degree angle to tail somites (lateral view), ~45 post-otic somites	gall bladder primordium formed and sometimes visible (irridescent on ventral view); blood circulation in gills visible	embryos begin taking gulps of air from the surface	***cela1.2***: pancreas; ***sfrp5***, ***klf5***: stomach; ***onecut***, ***hhex***, ***sox17a:*** gall bladder***;*** ***hhex***, ***nr1h5:*** liver
41	free swimming tadpole	conical shaped proctodeum formed, at angle of ~ 60 degrees to tail somites	myocardium thickens and develops trabeculae, atrium posterior to ventricle; torsion of gut starts; post-anal gut disappears; the pancreas, now visible in ventral view, posterior to left-sided stomach		***clcnkb:*** pronephros***;*** ***ins:*** pancreas***;*** ***myod1:*** tail somites; *s1pr1*: brain segments***;*** ***nkx2-5***, ***tpm1:*** myocardium***;*** ***hoxa13:*** proctodeum
42	free swimming tadpole	opercular fold first visible; head somites I and II disappeared	trachea and esophagus seperate		***sox2***: esophagus and stomach; ***nkx2.1:*** trachea and lung buds; ***sftpc***: lung buds
43	free swimming tadpole	cement gland starts to lose pigmentation; lateral line pits visible	stomach has lengthened further; pancreas shifted to right side [5]; duodenum formed by 1st gut coil constriction to anterior-right; midgut and hindgut form hairpin curve, visible on left side (will become the 'apex' of future intestinal coil)		***foxq1***, ***spdef***, ***bmpr1a***, ***cfap161***: stomach***;*** ***cela1.2:*** pancreas***;*** ***aldh1a2:*** duodenum***;***
44	free swimming tadpole	heart fully formed and clearly visible; barbels/tentacles start to grow; gills/branchial basket shrinking	septum begins to form in cardiac atrium which is slightly anterior to ventricle; midgut and hindgut lengthened more; the intestinal apex visible in ventral view as a "U" shape in the upper left quadrant of the gut cavity	visual avoidance behavior begins	***tnni3***, ***frzb***, ***sox9***, ***nkx2-5:*** heart; ***cdx2***: midgut-hindgut
45	feeding tadpole [3]	operculum partly covers the gills, hindlimb bud not visible	midgut and hindgut continue to lengthen; the intestinal apex begins to rotate inward in a counterclockwise trajectory; spleen forms; mesonephric kidney	tadpoles to start swim continuously and begin feeding	***darmin***, ***a2m:*** midgut, hindgut and liver; ***nkx2-5***: spleen primordium

EARLY ORGANOGENESIS

ORGANOGENESIS

GUT-COILING

PREMETAMORPHOSIS	46	feeding tadpole	crescent-shaped hindlimb bud first appears although is difficult to see; pigment cells appear on eye and around abdomen; trunk somite 1 disappeared	midgut and hindgut lengthen further- apex continues to rotate inward, forming multiple coils of intestine; blood circulation to gills diminishing	food can be seen in intestine as now feeding	
	47	feeding tadpole	irredescent gold-coloured abdominal wall surrounds coiled gut; blood circulation visible from heart to gills, and through paired dorsal aorta; cement gland starts to degenerate; barbels/tentacles longer	retinal ganglion cells have formed complex synapses with optic tectum neurons; thyroid gland begins to function; thymus gland detectable		***foxn1***: thymus
	48		hindlimb bud now clearly visible, with nearly semi-circular shape	retinal ganglion cells-optic tectum synapses more compact		***fgf8***, ***spry1***, ***sall4***: hindlimb bud
	49		hindlimb bud length equal to it's width	thyroid follicles first appear		
	50		hindlimb bud slightly constricted at base; tiny oval forelimb buds just visible	gonads undifferentiated		***hoxa13***: forelimb bud; ***spry4***: hindlimb bud
	51		hindlimb bud is cone-shaped; forelimb bud is oval shaped (in lateral view)	resorption vacuoles in thyroid follicles first appear		***hoxd10***, ***hoxa13***, ***hoxa9***: hindlimb bud
	52		hindlimb bud with slight 'wrist' indent; forelimb bud slightly constricted at base	5 complete coils of the intestine (internal and external coils)	regeneration competent [4]	***sox9***: hindlimb digits (cartilage elements)
	53		hindlimb bud paddle-like, with wrist constriction, hindlimb digits not discernable; forelimb bud with slight wrist constriction	onset of sexual differentiation of gonads	regeneration competent; athyroid animals have arrested development	
	54		hindlimb bud length (not including foot) 2x the width; foot paddle splayed with 5 digits and thinner inter-digital webbing; forelimb paddle with 4 digits and thinner inter-digital membranes	pronephric kidney begins to atrophy	thyroid hormone detectable in blood	***tbx4***, ***sall4***: interdigital mesenchyme
PROMETAMORPHOSIS	55		hindlimb length (not including foot) 3x width; forelimb hand rotates 90 degress, free parts of fingers as long as they are wide	all major muscles of hindlimb developed	regeneration restricted [4]	
	56		hindlimbs visible from above as they can rotate away from body; hindlimb length = ~ 5 tail somites; larval pigmentation pattern established	sexual differentiation of gonads into ovary or testis; hindlimb skeleton completey chondrified	regeneration restricted [4]	
	57		hindlimb length = ~ 9 tail somites; forelimb remains enclosed in operculum; lip folds form			
	58		hindlimb length = 11-12 tail somites; claws form on toes 1-3 (mostly always still white); forelimb emerges from operculum, elbows first; tail tip begins to atrophy	melanin/pigment deposited in under skin especially in tail	regeneration incompetent [4]	
	59		hindlimb muscular, claws start to harden and turn black, shortest toes first; finger tips reach base of hindlimb when forelimb is positioned along the abdomen; tentacles/barbels regress	melanin/pigment surrounds intersomitic blood vessels and between fibres of somites; forelimb muscles differentiated; pronephros no longer functional	regeneration incompetent [4]	
	60		gill chamber opening still wide; fingertips reach beyond base of hindlimb (almost to 'knee') when forelimb/arm is positioned along side of the abdomen; forelimb held posterior to heart; tail fins greatly reduced	pigmentation across body increases	regeneration incompetent [4]; animal switches from tail to leg swimming	
	61		first sign of gill resorption, openings to gill chamber much narrower; hindlimb and forelimb fully formed; forelimb at level of posterior half of heart	lateral finger-like protrusions from olfactory organ	cessation of feeding (due to oral and intestinal remodeling)	***obp***: olfactory organ
CLIMAX OF METAMORPHOSIS	62	tailed froglet	head slightly broader than abdomen; corner of mouth still infront of eye; forelimb reaches middle of heart; ventral tail fin gone from abdomen; adult skin on hindlimbs; only tiny nubs of barbels/tentacles remain.	tiny 'stirnorgan' (light detecting cells/part of pineal gland) appears; notochord atrophies along length of tail	peak levels of thyroid hormone in plasma	
	63	tailed froglet	head narrower than abdomen; barbels/tentacles (most often) completely gone; forelimb at level of anterior half of heart; tail shortens as tail somites are rapidly resorbed, tail still slightly longer than body			
	64		corner of mouth behind eye; tail length is about 1/3 of body length, at level of ankle when legs are in typical neutral position; body completely covered in adult skin, but 'border lines' clearly visible	thymus gland ventral-lateral to otic capsule		
	65		tail length a few millimeters, all tail somites have disappeared; body completely covered in adult skin, but 'border lines' still visible in some areas		feeding resumes	
	66	froglet	tail very nearly gone, not visible from ventral view; adult skin 'border lines' have disappeared, froglet body ~ 10mm long	skin remodelled with underlying dermis and secretory glands	thyroid hormone in plasma returns to prometamorphic levels	

FOOT NOTES

1 Dorsal-ventral pigment variation only occurs in some batches of embryos. Select 2-4-cell embryos with clear pigment variation - otherwise only accurate about 70% of time.
2 In the Normal Table and other texts, organ primordia are often called 'anlage'; they are visualized by as a thickening of specific cells via histology or by molecular markers. Search specific XAO terms on Xenbase for more molecular markers
3 NF stages 41-66 are not referred to by specific 'stage names' by Nieuwkoop and Faber
4 Regeneration classes from Aztekin et al 2021 PMID:34105722.
5 Left and right sides refer to that of the tadpole/embryo, and not the viewer.