

Appendix 3. List of characters modified from Peterson and Eernisse (2001) with additions from Smith et al. (2004) for echinoderms and hemichordates, Wheeler et al. (2001) for arthropods (not exhaustive), Rouse and Fauchald (1997) and Rouse (1999) for polychaetes, and Giribet and Wheeler (2002) for molluscs (a few other characters are individually referenced below). All characters are a/p unless otherwise indicated.

1. Mitochondria (Cavalier-Smith 1998). 2. Posterior flagella (Cavalier-Smith 1998). 3. Choanocytes. 4. Multicellularity with extracellular matrix: 0 = absent; 1 = present; 2 = present but with reduced or absent ECM 5. Septate junctions. 6. Gap junctions. 7. Hemidesmosomes. 8. Flagellar vanes. 9. Water-canal system. 10. Siliceous spicules. 11. Calcareous spicules. 12. Cross-striated rootlets. 13. Belt desmosomes. 14. Basal lamina. 15. Ciliated epidermis: 0 = absent; 1 = present with monociliated cells; 2 = present with multi- or multi- + monociliated cells. 16. Four polar bodies. 17. Position of polar bodies: 0 = absent; 1 = present and vegetal; 2 = present and animal; 3 = present and equatorial. 18. Spermatozoa. 19. Acrosome: 0 = absent; 1 = present; 2 = present as a distinct organelle. 20. Periacrosomal material. 21. Perforatorium (subacrosomal material). 22. Sperm transported by carrier cell (Nielsen, 2001). 23. Retroperitoneal gonads. 24. One axis prespecified during oogenesis. 25. Apical/blastoporal axis. 26. Dorsal/ventral axis. 27. Blastula stage. 28. Stereotypical cleavage pattern. 29. Spiral cleavage. 30. Tetrahedral 4-cell embryo (Shimotori and Goto, 2001). 31. Gastrulation. 32. Blastopore associated with larval/adult mouth with distinct and separate anus. 33. Mesoderm. 34. Endomesodermal muscle cells (see Martindale et al., 2002 for cnidarians). 35. Ectomesenchyme. 36. 4d endomesoderm. 37. Mesodermal germ bands derived from 4d. 38. Teloblastic growth. 39. Polar lobes. 40. Somatoblast. 41. Apical organ/tuft. 42. Apical organ with muscles extending to the hyposphere. 43. Apical ganglion with three serotonergic neurons and the lateral pair innervating the ciliary band (Hay-Schmidt 2000): 0 = absent; 1 = present; 2 = apical ganglion with many serotonergic neurons and a caudal serotonergic projection to the ciliary band. 44. Prototroch. 45. Pre- and peristomium. 46. Telotroch. 47. Neotroch. 48. Nonmuscular peritoneal cells in lateral regions of coelom. 49. Trimery. 50. Mesocoelomic ducts and pores. 51. Podocytes/terminal cells/nephrocytes. 52. Protonephridia with channel cell completely surrounding lumen. 53. Axial complex. 54. Gonads present with gametes passing through coelom and metanephridium. 55. Cuticle with chitin. 56. Trilaminar epicuticle. 57. Trilayered cuticle. 58. Ecdysis. 59. Digestive gut: 0 = absent; 1 = present; 2 = present without epithelium. 60. Digestive midgut without cilia. 61. Anus. 62. Pharyngotremy. 63. Stomochord. 64. Nerve cells. 65. Acetylcholine used as a neurotransmitter. 66. Nerve cells organized into distinct ganglia. 67. Circumpharyngeal brain with anterior and posterior rings of perikarya separated by a ring of neuropil. 68. Ventral nervous system 0 = absent; 1 = present; 2 = dorsal nervous system. 69. Gliointerstitial cell system. 70. Presence of anti-HRP-reactive glycoproteins in neural tissue (Haase et al., 2001). 71. Cannabinoid receptors (McPartland et al. 2001). 72. Closed circulatory system with dorsal and ventral blood vessels. 73. Hemerythrin. 74. Endogenous sialic acids. 75. tRNA Lys. 76. AUA methionine. 77. AGA and AGG serine. 78. Mitochondrial gene order cox3, q, nad6, cob (Boore and Stanton, 2002). 79. Mitochondrial atp8 not followed by atp6 (Boore and Stanton, 2002): 0 = absent; 1 = present; 2 = loss of atp8. 80. tRNA D followed by atp8 (Turbeville, 2002): 0 = absent; 1 = present; 2 = loss of D; 3 = loss of atp8. 81. Nuclear hormone receptors. 82. Hox genes. 83. Lox5. 84. UbdA. 85. Absence of Hox9/10 (Peterson, 2004). 86. Hox11/13a-c (Peterson, 2004). 87. Abd-B. 88. Post-1. 89. Post-2 (Callaerts et al. 2002). 90. Cnidocytes. 91. Planula larva. 92. Shell gland. 93. Shell

calcite/aragonite. 94. Two valves. 95. Mantle lobes. 96. Hypobranchial gland. 97. Ctenidia. 98. Filibranch ctenidia. 99. Labial palps. 100. Molluscan heart. 101. Burrowing foot. 102. Visceral/pedal ganglia. 103. Cephalic eyes. 104. Osphradia. 105. Veliger larva. 106. Lateral compression. 107. Reduction of anterior adductor. 108. External ligament. 109. Pseudonumphae. 110. Edentate. 111. Dysodont. 112. Operculum. 113. Torsion. 114. Dorsal mantle. 115. Ventral mantle fusion. 116. Lateralfrontal gill cilia. 117. Radula. 118. Byssus. 119. Visceral nerve cord. 120. Cephalic tentacles. 121. Abdominal sense organ. 122. Proboscis with rhyncocoel. 123. Lateral circulatory coeloms. 124. Fully segmented with compartmentalized coeloms. 125. Nuchal organs. 126. Parapodia. 127. Chaetae. 128. Sperm with singular annular mitochondrion. 129. Dipleurula larva with ventral anus. 130. Coelomic stacking. 131. Metamorphosis with new adult mouth. 132. Water-vascular system. 133. Pentameral symmetry. 134. Stereom. 135. Ocular plate rule. 136. Calcified stone canal and hydropore. 137. Articulated spines in dermis. 138. Tube feet with one-way valve. 139. Tube feet with internal ampullae. 140. Scleroblasts forming syncytium. 141. Jointed appendages. 142. Tripartite brain. 143. Mixocoel. 144. Wings on thorax. 145. Compound eyes. 146. Tracheae. 147. Tagmosis. 148. Spongins (Borchiellini et al. 2004). 149. Diactines (Borchiellini et al. 2004). 150. Let-7 (includes unpublished experiments, Sempere et al., in prep.).

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