Table S1: Ensembl transcript IDs, GenBank accession numbers and genomic location information of all Hox genes and relevant regulatory factors used in the present research.

| Gene | Chimpanzee | Human | Bushbaby | Mouse | Rabbit |
|------|------------|-------|----------|-------|--------|
| Hoxa1| ENSPTRG00000019010 | ENSG000000105991 | ENSOGAG00000012370 | ENSMUSG00000029844 | ENSOCUG000000015215 |
| Hoxa2| ENSPTRG00000019011 | ENSG000000105996 | ENSOGAG00000012372 | ENSMUSG00000014704 | ENSOCUG000000015205 |
| Hoxa3| ENSPTRG00000019012 | ENSG000000105997 | ENSOGAG00000027664 | ENSMUSG00000079560 | ENSOCUG00000027405 |
| Hoxa4| ENSPTRG00000023597 | ENSG000000197576 | ENSOGAG00000028670 | ENSMUSG0000000942 | ENSOCUG00000015190 |
| Hoxa5| ENSPTRG00000019015 | ENSG000000106004 | ENSOGAG00000011153 | ENSMUSG00000038253 | ENSOCUG00000029580 |
| Hoxa6| ENSPTRG00000039535 | ENSG000000106006 | ENSOGAG00000012384 | ENSMUSG00000043219 | ENSOCUG00000029344 |
| Hoxa7| ENSPTRG00000019017 | ENSG000000122592 | ENSOGAG00000032482 | ENSMUSG00000038236 | ENSOCUG00000015183 |
| Hoxa9| ENSPTRG00000019018 | ENSG00000078399 | ENSOGAG00000015000 | ENSMUSG00000038277 | ENSOCUG00000020585 |
| Hoxa10| ENSPTRG00000019019 | ENSG000000253293 | ENSOGAG00000012385 | ENSMUSG0000000938 | ENSOCUG00000029439 |
| Hoxa11| ENSPTRG00000019020 | ENSG00000005073 | ENSOGAG00000038210 | ENSMUSG0000000938 | ENSOCUG00000015170 |
| Hoxa12| ENSPTRG000000026843 | ENSG000000106031 | ENSOGAG00000028983 | ENSMUSG00000038203 | ENSOCUG00000024694 |
| Hoxb1| ENSPTRG0000009351 | ENSG00000120094 | ENSOGAG00000031645 | ENSMUSG00000018973 | ENSOCUG00000001720 |
| Hoxb2| ENSPTRG0000009352 | ENSG00000173917 | ENSOGAG00000029280 | ENSMUSG00000075588 | ENSOCUG00000024951 |
| Hoxb3| ENSPTRG00000040097 | ENSG00000120093 | ENSOGAG00000032090 | ENSMUSG00000048763 | ENSOCUG00000023337 |
| Hoxb4| ENSPTRG0000009354 | ENSG00000182742 | ENSOGAG00000033709 | ENSMUSG00000038692 | × |
| Hoxb5| ENSPTRG0000009355 | ENSG00000120075 | ENSOGAG00000032432 | ENSMUSG00000038700 | ENSOCUG00000025093 |
| Hoxb6| ENSPTRG0000009356 | ENSG00000108511 | ENSOGAG0000008661 | ENSMUSG0000000690 | ENSOCUG00000011560 |
| Hoxb7| ENSPTRG0000009357 | ENSG00000260602 | ENSOGAG0000008687 | ENSMUSG00000038721 | ENSOCUG00000019952 |
| Hoxb8| gi|694966057:190-921 | ENSG00000120668 | ENSOGAG00000029480 | ENSMUSG00000056648 | ENSOCUG00000029186 |
| Hoxb9| ENSPTRG0000009358 | ENSG00000170689 | ENSOGAG0000008668 | ENSMUSG00000020875 | ENSOCUG00000027316 |
| Hoxb13| ENSPTRG0000009360 | ENSG00000159184 | ENSOGAG00000032643 | ENSMUSG00000049604 | ENSOCUG00000012816 |
| Hoxc4| ENSPTRG00000005031 | ENSG00000198353 | ENSOGAG00000033004 | gi|54800434:329-1123 | ENSOCUG00000015516 |
| Hoxc5| ENSPTRG00000005032 | ENSG00000172789 | ENSOGAG00000036622 | ENSMUSG00000022485 | gi|65573349:211-825 |
| Hoxc6| ENSPTRG00000022997 | ENSG00000197757 | ENSOGAG0000003621 | ENSMUSG00000001661 | ENSOCUG0000004743 |
| Hoxc8| ENSPTRG00000005030 | ENST00000040584 | ENSOGAG0000003619 | ENSMICG00000011718 | ENSOCUG0000004741 |
| Hoxc9| ENSPTRG00000005029 | gi|24497546:97-879 | ENSOGAG0000003616 | gi|131810863:632-1414 | ENSOCUG00000001160 |
| Hoxc10| ENSPTRG00000005028 | ENSG00000180818 | ENSOGAG0000003615 | ENSMUSG00000022484 | ENSOCUG00000015176 |
| Hoxc11| ENSPTRG00000005027 | ENSG00000123388 | gi|395385038:115-1029 | ENSMUSG00000001156 | ENSOCUG0000001159 |
| Hoxc12| ENSPTRG00000005026 | ENSG00000123407 | ENSOGAG00000025383 | ENSMUSG00000050328 | ENSOCUG0000001157 |
| Gene   | Chimpanzee          | Human            | Bushbaby         | Mouse                       | Rabbit       |
|--------|---------------------|------------------|------------------|-----------------------------|--------------|
| Hoxc13 | ENSPTRG00000005025  | ENSG00000123364  | ENSOAG00000053091| ENSMUSG0000001655         | ENSOCUG0000001156 |
| Hoxd1  | ENSPTRG00000012673  | ENSG00000128645  | ENSOAG00000015712| ENSMUSG00000042448        | ENSOCUG00000015582 |
| Hoxd3  | ENSPTRG00000012672  | ENSG00000128652  | ENSOAG00000015710| ENSMUSG00000079277        | ENSOCUG0000014119 |
| Hoxd4  | ENSPTRG00000012671  | ENSG00000170166  | ENSOAG00000029168| ENSMUSG00000101174        | ENSOCUG0000002413 |
| Hoxd8  | ENSPTRG00000012669  | ENSG00000157879  | ENSOAG00000015707| ENSMUSG00000027102        | ENSOCUG0000002413 |
| Hoxd9  | ENSPTRG00000029132  | ENSG00000128709  | ENSOAG00000015697| ENSMUSG00000043342        | ENSOCUG00000023956 |
| Hoxd10 | ENSPTRG00000012667  | ENSG00000128710  | ENSOAG00000015694| ENSMUSG00000050368        | ENSOCUG0000008964 |
| Hoxd11 | ENSPTRG00000012666  | ENSG00000471273  | ENSOAG00000029520| ENSMUSG00000042499        | ENSOCUG000013942 |
| Hoxd12 | ENSPTRG00000012665  | ENSG00000170178  | ENSOAG00000015689| ENSMUSG000001823          | ENSOCUG000002412 |
| Hoxd13 | ENSPTRG00000012664  | ENSG00000128714  | ENSOAG00000027055| ENSMUSG0000001819         | ENSOCUG000029547 |
| Bmi1   | gi|525345322:470-1450 | gi|523462179:507-1487| gi|831220844:30-1439 | gi|133893249:472-1446 | gi|585859695:330-1310 |
| Mll    | ENSPTRG0000004344   | ENSG00000118058  | ENSOAG0000009345| ENSMUSG0000002028         | ENSOCUG000010127 |
| E2f6   | ENSPTRG0000011661   | ENSG00000169016  | ENSOAG00000013601| ENSMUSG0000057469         | ENSOCUG0000025804 |

| Gene   | Walrus              | Seal              | Giant panda      | Cat            |
|--------|---------------------|-------------------|------------------|----------------|
| Hoxa1  | gi|472355523:ref|XM_004397357.1:86-1084 | gi|585158618:ref|XM_006731525.1:86-1084 | ENSAMEG00000005924   | ENSFCAG00000007937 |
| Hoxa2  | gi|472355528:278-1414 | gi|585158622:ref|XM_006731527.1:493-1407 | ENSAMEG00000005913   | ENSFCAG00000007939 |
| Hoxa3  | gi|585161750:ref|XM_006733016.1:311-1444 | gi|472355530:334-1656 | ENSAMEG00000005904   | ENSFCAG0000028952 |
| Hoxa4  | gi|472355532:ref|XM_004397361.1:42-1016 | gi|585158624:ref|XM_006731528.1:6-485  | ENSAMEG00000005902   | ENSFCAG0000024158 |
| Hoxa5  | gi|472355534:ref|XM_004397362.1:626-1438 | gi|585161752:ref|XM_006733017.1:56-868  | ENSAMEG0000005898   | ENSFCAG0000031542 |
| Hoxa6  | gi|472355538:ref|XM_004397364.1:20-721  | gi|585161754:ref|XM_006733018.1:20-721  | ENSAMEG0000005892   | ENSFCAG0000027995 |
| Hoxa7  | gi|472355540:ref|XM_004397365.1:133-764 | gi|585161756:ref|XM_006733019.1:133-764 | ENSAMEG0000005891   | ENSFCAG0000022150 |
| Hoxa9  | gi|617619492:134-832   | gi|585158626:26-1349    | gi|585158626:26-1349    | ENSAMEG0000005885   | ENSFCAG0000007944 |
| Hoxa10 | gi|472355542:25-1260   | gi|585158628:25-1269    | gi|585158628:25-1269    | ENSAMEG0000005883   | ENSFCAG0000025359 |
| Hoxa11 | gi|472355547:ref|XM_004397368.1:63-1025 | gi|585161760:ref|XM_006731531.1:63-1025 | ENSAMEG0000005879   | ENSFCAG0000007945 |
| Hoxa13 | gi|472355570:ref|XM_004397379.1:124-912 | gi|585161770:ref|XM_006733026.1:565-1278 | ENSAMEG0000005877   | ENSFCAG0000028938 |
| Hoxb1  | gi|472350948:ref|XM_00439502.1:5-910  | gi|585174510:ref|XM_006739051.1:5-919  | ENSAMEG0000005893   | ENSFCAG0000028151 |
| Hoxb2  | gi|472350950:ref|XM_004395013.1:122-869| gi|585174508:ref|XM_006739050.1:122-1171| ENSAMEG0000005841   | ENSFCAG000002111 |
| Hoxb3  | gi|472350952:ref|XM_004395104.1:887-2167| gi|585174506:111-746   | ENSAMEG0000004942   | ENSFCAG0000006408 |
| Gene       | Walrus                  | Seal              | Giant panda             | Cat       |
|------------|-------------------------|-------------------|-------------------------|-----------|
| *Hoxb4*   | gi|472350954|ref|XM_004395105.1|:5-760   | gi|585174504|ref|XM_006739048.1|:1-486 | ENSAMEG00000004953 | ENSFCAG00000023225 |
| *Hoxb5*   | gi|59466153|ref|XM_007176389.1|:1-810   | gi|585197330|ref|XM_006749665.1|:280-1089 | ENSAMEG00000004967 | ENSFCAG00000002113 |
| *Hoxb6*   | gi|472350958|ref|XM_004395107.1|:607-1281 | gi|585174539|ref|XM_006739065.1|   | ENSAMEG00000004971 | ENSFCAG00000002114 |
| *Hoxb7*   | gi|472350962|100-753          | gi|576650303|ref|NW_006384051.1|:1-1375 | ENSAMEG00000004977 | ENSFCAG00000002118 |
| *Hoxb8*   | gi|823396039|397-1128         | gi|585197328|391-1122  | ENSAMEG00000004982 | gi|755790639|1-732   |
| *Hoxb9*   | gi|472350964|ref|XM_004395110.1|:205-955 | gi|585197326|ref|XM_006749654.1|63-813 | ENSAMEG00000004990 | ENSFCAG000002804 |
| *Hoxb13*  | gi|469049706|ref|             | gi|576651209|ref|NW_006383149.1|:618347..619985, | ENSAMEG00000004997 | ENSFCAG0000002120 |
| *Hoxc4*   | gi|472373565|ref|XM_004406194.1|:85-753  | gi|585152751|ref|XM_006728700.1|:72-740  | ENSAMEG0000000691 | ENSFCAG0000002246 |
| *Hoxc6*   | gi|472373561|ref|XM_004406192.1|:113-820 | gi|585152753|ref|XM_006728701.1|:113-820 | ENSAMEG0000000686 | ENSFCAG00000011201 |
| *Hoxc8*   | gi|472373567|ref|XM_004406195.1|:167-895 | gi|585152744|ref|XM_006728697.1|:129-857 | ENSAMEG0000000683 | ENSFCAG00000004769 |
| *Hoxc9*   | gi|472373569|ref|XM_004406196.1|:97-879  | gi|585152741|ref|XM_006728696.1|:97-879  | ENSAMEG0000000678 | ENSFCAG00000031037 |
| *Hoxc10*  | gi|472373571|ref|XM_004406197.1|:115-1143| gi|585152739|ref|XM_006728695.1|:113-1141| ENSAMEG0000000673 | ENSFCAG00000011202 |
| *Hoxc11*  | gi|472373573|ref|XM_004406198.1|:115-1029| gi|585152736|ref|XM_006728694.1|:115-1029| ENSAMEG0000000668 | ENSFCAG00000023232 |
| *Hoxc12*  | gi|472373575|ref|XM_004406199.1|:1-845   | gi|585152734|ref|XM_006728693.1|:1-839   | ENSAMEG0000000665 | ENSFCAG00000023389 |
| *Hoxc13*  | gi|472373577|ref|XM_004406200.1|:63-1052 | gi|585201026|ref|XM_006751376.1|:114-846 | ENSAMEG0000000661 | ENSFCAG00000027459 |
| *Hoxd1*   | gi|472379322|ref|XM_004409017.1|:127-1107| gi|585175610|ref|XM_006739539.1|:184-900  | ENSAMEG00000001828 | gi|755759773|1-654   |
| *Hoxd3*   | gi|472379320|84-1382           | gi|585175597|ref|XM_006739533.1|:84-1382 | ENSAMEG00000001830 | gi|755759777|274-1467 |
| *Hoxd4*   | gi|472379318|ref|XM_004409015.1|:555-1328| gi|585175599|ref|XM_006739531.4|:250-1026 | ENSAMEG00000001837 | gi|755759780|1421-2188 |
| *Hoxd8*   | gi|472379314|1-885             | gi|585175612|ref|XM_006739540.1|:19-621   | ENSAMEG00000001838 | ENSFCAG00000023730 |
| *Hoxd9*   | gi|472379312|31-1059           | gi|585175614|22-1002  | ENSAMEG00000001843 | ENSFCAG00000013346 |
| *Hoxd10*  | gi|472379310|ref|XM_004409011.1|:65-1087 | gi|585175601|ref|XM_006739535.1|:168-1190 | ENSAMEG00000001849 | ENSFCAG0000006264 |
| *Hoxd11*  | gi|472379326|ref|XM_004409019.1|:209-921 | gi|585175616|ref|XM_006739542.1|   | ENSAMEG00000001856 | ENSFCAG00000030594 |
| *Hoxd12*  | gi|472379308|ref|XM_004409010.1|:1-813   | gi|585175603|ref|XM_006739536.1|:1-813   | ENSAMEG00000001858 | gi|755759735|ref|XM_011285399.1|   |
| *Hoxd13*  | gi|472379306|ref|XM_004409009.1|:82-1110 | gi|585175605|ref|XM_006739537.1|:2-835   | ENSAMEG00000001865 | ENSFCAG00000030694 |
| *Bmi1*    | gi|823392672|531-1511          | gi|585155017|53-982   | gi|752381722|242-1222  | gi|755767831|1-11688 |
| *Mll*     | gi|823429941|793-1141          | gi|585180014|1-11295  | ENSAMEG00000013007 | gi|755767831|1-11688 |
| *E2f6*    | gi|823409521|228-1076          | gi|585176517|225-1073 | ENSAMEG00000011667 | ENSFCAG00000011952 |
| Gene | Rhinoceros | Minke whale | Bowhead whale |
|------|------------|-------------|---------------|
| Hoxa1 | gi|594636392|ref|XM_007171517.1|:29-1027 |
| Hoxa2 | gi|478489137|ref|XM_007176394.1|:1-436 |
| Hoxa3 | gi|478489139|ref|XM_007171533.1|:206-897 |
| Hoxa4 | gi|594656150|ref|XM_007176388.1|:316-807 |
| Hoxa5 | gi|545214278|ref|XM_007175241.1|:7-357 |
| Hoxa6 | gi|594656396|ref|XM_007176508.1|:1-850 |
| Hoxa7 | gi|594656148|ref|XM_007176387.1|:1-897 |
| Hoxa8 | gi|478489141|ref|XM_004418894.1|:462-1601 |
| Hoxa9 | gi|478489139|ref|XM_004418890.1|:73-891 |
| Hoxa10 | gi|594656150|ref|XM_007176389.1|:1-810 |
| Hoxa11 | gi|478489137|ref|XM_007176373.1|:115-1111 |
| Hoxa12 | gi|594656396|ref|XM_007176508.1|:1-850 |
| Hoxa13 | gi|478489137|ref|XM_007176373.1|:115-1111 |
| Hoxa14 | gi|594656148|ref|XM_007176387.1|:1-897 |
| Hoxa15 | gi|478489141|ref|XM_004418894.1|:462-1601 |
| Hoxa16 | gi|478489137|ref|XM_007176373.1|:115-1111 |
| Hoxa17 | gi|594656150|ref|XM_007176388.1|:316-807 |
| Hoxa18 | gi|478489137|ref|XM_007176373.1|:115-1111 |
| Hoxa19 | gi|594656148|ref|XM_007176387.1|:1-897 |
| Hoxa20 | gi|478489141|ref|XM_004418894.1|:462-1601 |
| Hoxa21 | gi|478489137|ref|XM_007176373.1|:115-1111 |

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| Gene       | Sperm whale | Baiji          | Killer whale          | Finless porpoise |
|------------|-------------|----------------|-----------------------|-----------------|
| **Hoxa1**  | gi|593734812|ref|XM_007112779.1|:32-1030 | gi|602711801|ref|XM_007466074.1|:86-1081 | gi|465984997|ref|XM_004265685.1|:86-1084 | unpublished |
| **Hoxa2**  | gi|593734809|ref|XM_007112778.1|:606-1508 | gi|602711805|ref|XM_007466076.1|:496-1398 | gi|465984981|ref|XM_004265660.1|:495-1397 | — |
| **Hoxa3**  | gi|593734821|ref|XM_007112783.1|:273-1235 | gi|602711898|ref|XM_007466122.1 | gi|465985108|ref|XM_004265685.1|:190-1302 | — |
| **Hoxa4**  | gi|593734819|ref|XM_007112782.1|:19-477  | gi|602711811|ref|XM_007466079.1|:42-1022 | gi|465984983|ref|XM_004265661.1|:42-1022 | — |
| **Hoxa5**  | gi|593734807|ref|XM_007112777.1|:1713-2525 | gi|602711809|ref|XM_007466078.1|:627-1439 | gi|465984985|ref|XM_004265662.1|:626-1438 | — |
| **Hoxa6**  | gi|593734805|ref|XM_007112776.1|:192-893  | gi|465984987|ref|XM_004265663.1|:20-721  | gi|465984987|ref|XM_004265663.1|:20-721  | — |
| **Hoxa7**  | gi|472355540|ref|XM_004397365.1|:133-764  | gi|471379481|ref|XM_004377481.1|133-830  | gi|465984990|ref|XM_004265664.1|133-821  | — |
| **Hoxa9**  | gi|593734798|ref|XM_007112773.1|:112-930  | gi|602711815|ref|XM_007466081.1|:1-822   | gi|465984999|ref|XM_004265666.1|:81-899  | — |
| **Hoxa10** | gi|593734800|:713-1951  | gi|602711817|ref|XM_007466082.1 | gi|593734800|:713-1951 | — |
| Gene  | Sperm whale          | Baiji          | Killer whale | Finest purpose |
|-------|----------------------|----------------|--------------|----------------|
| Hoxa1 | gi|593734795|ref|XM_007112772.1| | gi|602711819|ref|XM_007466083.1|:73-1023 | gi|465985004|ref|XM_004265667.1|:73-1035 |
| Hoxa3 | gi|593734816|ref|XM_007112781.1| | gi|602711821|ref|XM_007466084.1|:127-894 | gi|465985113|ref|XM_004265686.1| |
| Hoxb1 | gi|593727034|ref|XM_007109421.1|:1-897 | gi|602709837|ref|XM_007465110.1|:6-902 | gi|466072474|ref|XM_004282672.1|:6-902 |
| Hoxb2 | gi|593727032|ref|XM_007109424.1|:1-1059 | gi|602709835|ref|XM_007465109.1|:121-1170 | gi|466072469|ref|XM_004282671.1|:121-1182 |
| Hoxb3 | gi|593727120:425-1636 | gi|602709833|ref|XM_007465108.1| | gi|466072449|ref|XM_004282667.1|:877-2151 | |
| Hoxb4 | gi|593727030|ref|XM_007109423.1|:54-809 | gi|602709831|ref|XM_007465107.1|:1-756 | gi|466072464|ref|XM_004282670.1|:63-818 |
| Hoxb5 | gi|593727027|ref|XM_007109422.1|:1-810 | gi|602709827|ref|XM_007465105.1|:280-1089 | gi|466072459|ref|XM_004282669.1|:278-1087 |
| Hoxb6 | gi|593727025|ref|XM_007109421.1|:1-675 | gi|602709829|ref|XM_007465106.1| | gi|466072444|ref|XM_004282666.1|:1-675 |
| Hoxb7 | gi|593727023|ref|XM_007109420.1|:14-667 | gi|602709825|ref|XM_007465104.1|:4-667 | gi|466072439|ref|XM_004282665.1|:100-753 |
| Hoxb8 | gi|593727021|ref|XM_007109419.1| | gi|602709823:238-969 | | gi|466072434:232-963 | |
| Hoxb9 | gi|593727018|ref|XM_007109418.1|:89-841 | gi|602709821|ref|XM_007465102.1|:203-955 | gi|466072430|ref|XM_004282663.1|:62-814 |
| Hoxb13 | gi|593727115|ref|XM_007109460.1|:1-850 | gi|602709819|ref|XM_007465101.1|:145-991 | gi|466072425|ref|XM_004282662.1|:145-994 |
| Hoxc4 | gi|593740513|ref|XM_007125724.1|:89-883 | x | gi|577861026:688-1482 | |
| Hoxc5 | gi|593740511|ref|XM_007125723.1|:83-751 | x | gi|466030860|ref|XM_004274230.1|:77-745 |
| Hoxc6 | gi|593740505|ref|XM_007125720.1|:889-1596 | x | gi|578043747|ref|XM_001289868.1|:113-820 |
| Hoxc8 | gi|593740517|ref|XM_007125726.1|:48-774 | x | gi|466030865|ref|XM_004274231.1|:149-875 |
| Hoxc9 | gi|593740519|ref|XM_007125727.1|:180-962 | x | gi|466030870|ref|XM_004274232.1|:97-879 |
| Hoxc10 | gi|593740521|ref|XM_007125728.1|:61-1089 | x | gi|466030874|ref|XM_004274233.1|:113-1141 |
| Hoxc11 | gi|593740528|ref|XM_007125730.1|:52-969 | x | gi|466030879|ref|XM_004274234.1|:115-1032 |
| Hoxc12 | gi|593740523|ref|XM_007125729.1|:1-848 | x | gi|466030884|ref|XM_004274235.1|:1-839 |
| Hoxc13 | gi|593740681|ref|XM_007125804.1|:1-699 | x | gi|466030889|ref|XM_004274236.1|:63-1064 |
| Hoxd1 | gi|593733188|ref|XM_007112007.1|:1-981 | gi|602731503|ref|XM_007451092.1|:1-981 | gi|465995037|ref|XM_004267351.1|:1-981 |
| Hoxd3 | gi|593733186:1-1299 | gi|602731489|ref|XM_007451085.1|:79-1377 | gi|465995033:79-1377 | |
| Hoxd4 | gi|593733184|ref|XM_007112005.1|:891-1652 | gi|602731491|ref|XM_007451086.1|:557-1327 | gi|465995027|ref|XM_004267349.1|:557-1321 |
| Hoxd8 | gi|593733182|ref|XM_007112004.1|:42-834 | gi|602731495|ref|XM_007451088.1|:42-843 | gi|465995015|ref|XM_004267347.1|:537-1338 |
| Hoxd9 | gi|593733178:22-1053 | gi|602731497:115-1152 | | gi|465995009:115-1146 | |
| Hoxd10 | gi|593733176|ref|XM_007112001.1|:227-1249 | gi|602731499|ref|XM_007451090.1|:211-1233 | gi|465995005|ref|XM_004267345.1|:65-1087 |
| Hoxd11 | gi|593733174|ref|XM_007112000.1|:1-813 | gi|602731501:1-1035 | | gi|465995435|ref|XM_004267414.1| |
| Hoxd12 | gi|593733174|ref|XM_007112000.1|:1-813 | gi|602731487|ref|XM_007451084.1|:1-816 | gi|465994992|ref|XM_004267343.1|:1-813 |
| Gene  | Sperm whale | Baiji | Killer whale | Finless porpoise |
|-------|-------------|-------|--------------|------------------|
| Hoxd13 | gi|224016300|gb|FJ455478.1|:1-966 | gi|602731485|ref|XM_007451083.1|:76-1110 | gi|465994989|ref|XM_004267342.1|:76-1107 | — |
| Bmi1  | gi|593760098|:215-1195 | gi|602683948|:525-1505 | gi|821413452|:501-1481 | — | — |
| Mll   | gi|593771755|:11-9316 | gi|602688308|:18-11942 | gi|466026765|:18-11945 | — | — |
| E2f6  | gi|593744636|:44-742 | gi|602689504|:1-855 | gi|821399959|:1-855 | — | — |

| Gene  | Bottlenose dolphin | Cow | Pig | Ying fox |
|-------|---------------------|-----|-----|----------|
| Hoxa1 | ENSTTRG00000006761 | ENSBTAG00000013263 | ENSSSCG00000016707 | ENSPVAG00000002476 |
| Hoxa2 | ENSTTRG00000006765 | ENSBTAG00000008138 | ENSSSCG00000016706 | ENSPVAG00000002484 |
| Hoxa3 | ENSTTRG00000006769 | ENSBTAG00000008139 | ENSSSCG00000016705 | ENSPVAG00000002486 |
| Hoxa4 | ENSTTRG00000006775 | ENSBTAG00000001063 | ENSSSCG00000016704 | gi|759124508:52-693 |
| Hoxa5 | ENSTTRG00000006777 | ENSBTAG00000012211 | ENSSSCG00000016703 | ENSPVAG00000002490 |
| Hoxa6 | ENSTTRG00000006778 | ENSBTAG00000024341 | ENSSSCG00000016702 | ENSPVAG00000002491 |
| Hoxa7 | ENSTTRG00000006782 | ENSBTAG0000001455 | ENSSSCG00000016701 | ENSPVAG00000002494 |
| Hoxa9 | gi|460094811|ref|NW_004254427.1|:1794..180 | gi|460363619|ref|NW_004198077.1|:287770..286332 |
| Hoxa10 | ENSTTRG00000003476 | ENSBTAG00000040082 | ENSSSCG00000021204 | ENSPVAG00000002499 |
| Hoxa11 | ENSTTRG00000003480 | ENSBTAG00000014738 | ENSSSCG00000016698 | ENSPVAG00000002500 |
| Hoxa13 | gi|470603374|ref|XM_004312987.1| | gi|305855193|ref|NM_001195342.1| | gi|759124508:1-855 |
| Hoxb1 | ENSTTRG000000012240 | ENSBTAG00000007603 | ENSSSCG00000017532 | ENSPVAG00000015520 |
| Hoxb2 | ENSTTRG000000012244 | ENSBTAG00000009979 | ENSSSCG00000017533 | ENSPVAG00000015521 |
| Hoxb3 | ENSTTRG000000012246 | ENSBTAG00000021427 | ENSSSCG00000017534 | ENSPVAG00000015522 |
| Hoxb4 | ENSTTRG000000012249 | ENSBTAG00000039599 | ENSSSCG00000017535 | ENSPVAG00000015523 |
| Hoxb5 | ENSTTRG000000012251 | ENSBTAG00000045835 | ENSSSCG00000017540 | ENSPVAG00000015524 |
| Hoxb6 | ENSTTRG000000012252 | gi|741896445:5049-5471 | ENSSSCG00000017539 | ENSPVAG00000015525 |
| Hoxb7 | gi|460080811|ref|NW_004267563.1|:1284..1 | gi|459775095|ref|NW_004347235.1|:853..1 |
| Hoxb8 | ENSTTRG000000012260 | gi|741963565:57-485 | ENSSSCG00000017537 | ENSPVAG00000015529 |
| Hoxb9 | ENSTTRG000000012262 | ENSBTAG00000025009 | ENSSSCG00000017536 | gi|759185596:96-848 |
| Hoxb13 | ENSTTRG000000012314 | ENSBTAG00000014663 | ENSSSCG00000017541 | ENSPVAG00000015531 |
| Hoxc4 | ENSTTRG00000004529 | ENSBTAG0000003304 | ENSSSCG0000000285 | ENSPVAG00000014722 |
| Gene  | Bottlenose dolphin | Cow          | Pig           | Ying fox       |
|-------|--------------------|--------------|---------------|----------------|
| Hoxc5 | ENSTTRG000000004532| ENSBTAG000000009634 | ENSSSCG000000027996 | ENSPVAG00000014723 |
| Hoxc6 | ENSTTRG000000004534 | ENSBTAG000000009238 | ENSSSCG000000030585 | ENSPVAG00000014724 |
| Hoxc8 | ENSTTRG000000004538 | ENSBTAG00000012149 | ENSCPG000000024489 | ENSPVAG00000014725 |
| Hoxc9 | ENSTTRG000000010853 | ENSBTAG00000005606 | chr5:19645413..1964667 | ENSSSCG00000011039 |
| Hoxc10| ENSTTRG000000004540 | ENSBTAG00000003278 | ENSSSCG000000027615 | gi|759165771:114-1142 |
| Hoxc11| gi|470595930:115-1032 | gi|545825435[ref|XM_003355425.3] | ENSPVAG00000012298 |
| Hoxc12| ENSTTRG000000004543 | ENSBTAG00000000924 | ENSSSCG00000000281 | ENSPVAG00000012297 |
| Hoxc13| ENSTTRG000000004546 | ENSBTAG00000000923 | ENSSSCG00000000279 | ENSPVAG00000012296 |
| Hoxd1 | ENSTTRG00000002522 | ENSBTAG00000015840 | ENSSSCG00000015986 | ENSPVAG00000017425 |
| Hoxd3 | ENSTTRG00000013779 | ENSBTAG0000004835 | gi|545874786:1227-2525 | ENSPVAG00000017421 |
| Hoxd4 | ENSTTRG00000013778 | ENSBTAG00000039581 | ENSSSCG00000015984 | gi|759094456:1238-1999 |
| Hoxd8 | ENSTTRG00000013777 | gi|741916274:80-913 | ENSSSCG00000015983 | ENSPVAG00000017420 |
| Hoxd9 | ENSTTRG00000013773 | ENSBTAG00000016033 | ENSSSCG00000015982 | gi|759094488:481-1497 |
| Hoxd10| gi|470607996:45-1067 | ENSBTAG00000016030 | ENSSSCG00000015981 | ENSPVAG00000017418 |
| Hoxd11| gi|459774200[ref|NW_004348130.1]:1..1016 | ENSBTAG00000003330 | gi|545874814[ref|XM_005671983.1] | ENSPVAG00000017417 |
| Hoxd12| ENSTTRG00000013772 | ENSBTAG0000004314 | ENSSSCG00000015980 | ENSPVAG00000017416 |
| Hoxd13| ENSTTRG00000013771 | ENSBTAG0000004313 | ENSSSCG00000015979 | ENSPVAG00000017415 |
| Bmi1  | gi|460361160[ref|NW_004200536.1]:100306..103166 | gi|84000132:232-1212 | gi|545873578:172-1152 | gi|759132282:532-1512 |
| Mll   | ENSTTRG000000004289 | ENSBTAG00000018093 | ENSSSCG00000023234 | ENSPVAG00000006246 |
| E2f6  | ENSTTRG00000013168 | ENSBTAG00000048286 | ENSSSCG00000026161 | ENSPVAG00000008652 |

| Gene  | Little brown bat | Hedgehog | Sloth | Armadillo |
|-------|------------------|----------|-------|-----------|
| Hoxa1 | ENSMULG00000001496 | ENSEUEUG000000011144 | × | ENSDNOG000000047948 |
| Hoxa2 | ENSMULG000000014499 | ENSEUEUG00000000593 | ENSCHOG000000009848 | ENSDNOG000000010786 |
| Hoxa3 | ENSMULG000000014502 | ENSEUEUG00000003189 | ENSCHOG000000009854 | ENSDNOG00000003211 |
| Hoxa4 | gi|558125085:268-753 | ENSEUEUG00000005514 | ENSCHOG00000003332 | gi|226822844:332075-331463, c330906-330563 |
| Hoxa5 | ENSMULG000000028593 | ENSEUEUG00000009904 | × | ENSDNOG000000034242 |
| Hoxa6 | ENSMULG000000014517 | gi|617619494:20-721 | ENSCHOG000000009037 | ENSDNOG00000001633 |
| Hoxa7 | ENSMULG000000008289 | gi|617619492:134-832 | × | ENSDNOG000000048295 |
| Hoxa9 | gi|584040953:85-759 | ENSEUEUG00000009872 | × | ENSDNOG000000043901 |
| Gene       | Little brown bat | Hedgehog              | Sloth                          | Armadillo                  |
|------------|-----------------|-----------------------|--------------------------------|----------------------------|
| Hoxa10     | ENSLUG0000000027272 | ENSEEU000000009849   | ×                              | ENSDOG000000039533         |
| Hoxa11     | ENSLUG000000008300  | ENSEEU000000009724   | ENSCHO000000007426             | ENSDOG000000017503         |
| Hoxa13     | ENSLUG000000008332  | gi|617619544|XM_007526917.1| scaffold_1425:33982..32538 | ENSDOG000000047528         |
| Hoxb1      | ENSLUG000000008429  | gi|61763311|XM_007529991.1| scaffold_8915:25847..23714 | ENSDOG00000006826         |
| Hoxb2      | ENSLUG000000008433  | gi|61763308:15-1076 | scaffold_1425:33982..32538   | ENSDOG000000047374         |
| Hoxb3      | ENSLUG000000008445  | gi|617633502|XM_007529988.1| ×                              | ENSDOG000000043480         |
| Hoxb4      | gi|58170854:1-540    | ENSEEU000000007049   | ×                              | ENSDOG000000039782         |
| Hoxb5      | ENSLUG000000014513  | gi|617633293|XM_007529985.1| ×                              | ENSDOG000000042538         |
| Hoxb6      | ENSLUG000000010649  | ENSEEU000000005642   | ENSCHO00000000614             | ENSDOG000000006841         |
| Hoxb7      | ENSLUG000000002609  | ENSEEU000000014244   | ENSCHO00000000646             | gi|476582478|NW_004463870.1:492..1925|477468771|NW_004462340.1:216330..217781 | ENSDOG000000043480         |
| Hoxb8      | ×                | gi|617633287:242-973   | ×                              | gi|476582478|NW_004463870.1:1417..1      | ENSDOG0000000043480         |
| Hoxb9      | ENSLUG000000011677  | ENSEEU000000014249   | ×                              | ENSDOG000000024386         |
| Hoxb13     | ENSLUG000000029480  | ENSEEU000000014337   | ENSCHO00000002354             | ENSDOG000000015177         |
| Hoxc4      | ENSLUG000000017706  | ENSMUS000000075394   | ×                              | ENSDOG000000046396         |
| Hoxc5      | ENSLUG00000000488   | ENSEEU000000012980   | scaffold_17321:18344..16692   | ENSDOG000000009604         |
| Hoxc6      | ENSLUG00000000485    | ENSEEU000000010293   | ENSCHO000000013391            | gi|476573758|NW_004482590.1:1068037..1069592 |
| Hoxc8      | ENSLUG000000003097   | ENSEEU000000008079   | ×                              | ENSDOG000000034735         |
| Hoxc9      | ENSLUG00000000483    | ENSEEU00000002788    | ENSCHO000000005906            | ENSDOG000000035825         |
| Hoxc10     | ENSLUG00000000482    | gi|617579660:129-1157  | ×                              | ENSDOG000000017505         |
| Hoxc11     | ENSLUG00000000470    | gi|617580207|XM_007518304.1| scaffold_46159:1049..1      | gi|476573758|NW_004482590.1:1011220..1013200 |
| Hoxc12     | ENSLUG000000002698   | gi|617580211|XM_007518305.1| ×                              | ENSDOG00000003631         |
| Hoxc13     | ENSLUG000000015050   | gi|488552207|XM_004485128.1| ×                              | gi|488552207|XM_004485128.1| ENSDOG000000019807         |
| Hoxd1      | ENSLUG000000029447   | gi|617609948|XM_007524704.1| scaffold_145246:3646..5404  | ENSDOG000000004405         |
| Hoxd3      | ENSLUG000000012510   | gi|617609912|XM_007524690.1| scaffold_145246:3646..5404  | ENSDOG000000004593         |
| Hoxd4      | ENSLUG000000012508   | gi|617609908:169-966   | ENSCHO000000004176            | ENSDOG000000019807         |
| Hoxd8      | ENSLUG00000002864    | gi|617666440|XM_007539198.1| ×                              | ENSDOG000000008112         |
| Hoxd9      | GL429772:7092016..709353 | ENSEEU00000003473 | ×                              | gi|488583112:1-591            | ENSDOG0000000034389         |
| Hoxd10     | ENSLUG000000007048   | ENSEEU000000003440   | ENSCHO000000011881            | ENSDOG000000044260         |
| Hoxd11     | ENSLUG000000007030   | gi|617609945|XM_007524703.1| ×                              | ENSDOG000000044260         |
| Gene  | Little brown bat | Hedgehog  | Sloth  | Armadillo |
|-------|-----------------|-----------|--------|-----------|
| Hoxd12| ENSMLUG0000007009 | gi|617609899|ref|XM_007524686.1| × | ENSDNOG00000047700 |
| Hoxd13| ENSMLUG0000006997 | ENSEEU|0000005384 | ENSCHOG00000004807 | ENSDNOG00000019799 |
| Bmi1  | gi|581500333:81-1061 | gi|617550589:17-997 | ENSCHOG00000011962 | gi|82130183:43-1020 |
| Mll   | ENSMLUG0000014086 | ENSEEU|0000015428 | ENSCHOG00000007116 | ENSDNOG00000011530 |
| E2f6  | gi|558186255:15-734 | ENSEEU|000001403 | ENSCHOG00000005114 | ENSDNOG0000000258 |

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| Gene    | Manatee                        | Elephant       | Kangaroo           |
|---------|-------------------------------|----------------|-------------------|
| **Hoxc6** | gi|46071832|ref|NW_004443963.1|22412137..22410538,22411024..22409517 | ENSLAFG0000000117 | gi|359754105:99007-99406, 100201-100508 |
| **Hoxc8** | gi|471366945|ref|XM_004373948.1|177-905 | ENSLAFG00000018140 | gi|359754105:77755-78190, 79694-79986 |
| **Hoxc9** | gi|471366943|ref|XM_004373947.1|80-832 | ENSLAFG0000002366 | gi|359754105:67248-67785, 69691-69935 |
| **Hoxc10** | gi|471366959|ref|XM_004373955.1|103-1131 | ENSLAFG00000018137 | gi|359754105:50619-51369, 55062-55339 |
| **Hoxc11** | gi|471366961|ref|XM_004373956.1|115-1023 | ENSLAFG00000018133 | gi|359754105:36794-37460, 38842-39074 |
| **Hoxc12** | gi|471366963|ref|XM_004373957.1|1-848 | ENSLAFG00000024750 | gi|359754105:18156-18750, 19672-19910 |
| **Hoxc13** | gi|471366965|ref|XM_004373958.1|1-996 | ENSLAFG00000030195 | gi|359754105:815-1580, 6845-7101 |
| **Hoxd1** | gi|471370046|ref|XM_004375480.1|41-1027 | gi|344268815|ref|XM_003406204.1| | gi|359754115:103019-103688, 104095-104429 |
| **Hoxd3** | gi|471370048|87-1379 | ENSLAFG00000005477 | gi|359754115:82485-83025, 84886-85634 |
| **Hoxd4** | gi|471370050|ref|XM_004375482.1|248-1015 | ENSLAFG00000005480 | gi|359754115:64199-64610, 65210-65514 |
| **Hoxd8** | gi|460718322|ref|NW_004443973.1|8263628..8262140,8262949..8261457 | ENSLAFG00000004364 | gi|359754115:40138-40768, 41213-41508 |
| **Hoxd9** | gi|823389162|ref|XM_012555287.1 | ENSLAFG000000111494 | gi|359754115:32265-33039, 33409-33647 |
| **Hoxd10** | gi|471370052|ref|XM_004375483.1|65-1087 | ENSLAFG00000013262 | gi|359754115:25995-26739, 28186-28463 |
| **Hoxd11** | gi|471370258|ref|XM_004375585.1| | gi|344268349|ref|XM_003405975.1| | gi|359754115:15809-16490, 17298-17536 |
| **Hoxd12** | gi|471370054|ref|XM_004375584.1|1-816 | ENSLAFG00000017497 | gi|359754115:7229-7793, 8091-8329 |
| **Hoxd13** | gi|471370260|ref|XM_004375586.1|7-753 | ENSLAFG00000027629 | gi|359754115:121-895, 1981-2231 |
| **Bmi1** | gi|460718284|ref|NW_004444011.1|6074600..6071528 | gi|731479430:91-1071 | ENSMEUG00000011706 |
| **Mll** | gi|471408281|18-11918 | ENSLAFG00000014805 | ENSMEUG0000000157 |
| **E2f6** | gi|823387324|1-870 | ENSLAFG00000021573 | ENSMEUG00000007957 |

Note: Sequences marked with overstriking were acquired by local blast from genome data and marked with × were not acquired.
Figure S1 The proportion of repetitive elements numbers to total repeats in different gene regions among species
Table S2 Lineage-specific amino acids changes in regulatory factors and Hox genes among mammals

| Gene | Sites | Amino acid change | Species          | Qualitative Change† | Total |
|------|-------|-------------------|------------------|---------------------|-------|
| Hoxa2 | 295   | S-P              | Pinnipedia       | α, H                 | 2     |
| Hoxa3 | 341   | D-N              | Odontoceti       | α                   | 1     |
| Hoxa6 | 34    | A-T              | Xenarthra        | P                   | 1     |
| Hoxb9 | 72    | G-A              | Pinnipedia       | P          α, P, P, F, R, P | 3     |
| HOX   |       | G-A              | Minke whale      | P                   | 1     |
| Hoxc5 | 86    | L-P              | Hominoid         | P, N, P, K, F, α, α, R, P, H | 10    |
| Hoxc11| 64    | S-P              | Cetartiodactyla  | α, H                 | 2     |
| Hoxd1 | 220   | E-K              | Cetaceans        | α                   | 2     |
| Hoxd12| 41    | P-S              | Cetaceans        | α, H                 | 2     |
|       | 68    | A-T              | Odontoceti       | P                   | 1     |
|       | 186   | R-Q              | Cetaceans        | pH                  | 1     |

†Radical changes in amino acid properties under category 6-8 derived from TreeSAAP. Amino acid property symbols used: Total non-bonded energy (E), Mean r.m.s. fluctuational displacement(F), Hydrophathy (h), Normalised consensus hydrophobicity (Hnc), Surrounding hydrophobicity (H), Polarity (p), Coil tendency (P), Isoelectric point (ph), Turn tendency (P), Solvent accessible reduction ratio (Ra), Power to be at the N-terminal (an), Bulkiness (B), Buriedness (B), Helical contact area (Ca), Short- and medium-rangenon-bonded energy (Esm), Thermodynamic transfer hydrophobicity (Ht), Compressibility (K0), Molecular weight (Mw), Average number of surrounding residues (Ns), Alpha-helical tendency (pa), Partial specific volume (V0), Power to be at the C-terminal (ac), Refractive index (μ), β-structure tendencies (Pβ), Average number of surrounding residues (Ns), Molecular volume (Mv).
Figure S2 Three-dimensional structure distribution of positively selected sites (red balls) and Lineage-specific radical amino acids change sites (brown balls) in corresponding proteins. Homeodomian of Hox proteins, DNA binding region of E2f6, and transcriptional activation region of MII are colored yellow. N- and C-terminal regions are ocean blue and violet respectively.
### Table S3 Parameter estimates under branch models among Hox genes and Regular factors

| Families | Genes | In L | Value | LRT( 2ΔI) | df | P value |
|----------|-------|------|-------|-----------|----|---------|
| Hoxa1    |       | 0.0808 | 4930.529558 | - | 61.644474 | 51 | 0.14607 |
| Hoxa2    |       | 0.0793 | 4217.583311 | - | 64.804038 | 53 | 0.128256 |
| Hoxa3    |       | 0.05471 | 7779.334064 | - | 129.497984 | 53 | 2.40E-08 |
| Hoxa4    |       | 0.10786 | 4506.959354 | - | 69.884778 | 53 | 0.059894 |
| Hoxa5    |       | 0.05451 | 2570.157481 | - | 47.877498 | 51 | 0.598438 |
| Hoxa6    |       | 0.04696 | 2630.365348 | - | 45.234758 | 53 | 0.76698 |
| Hoxa7    |       | 0.09626 | 3616.407383 | - | 74.92431 | 51 | 0.016212 |
| Hoxa9    |       | 0.0494 | 3553.334811 | - | 68.366406 | 51 | 0.052596 |
| Hoxa10   |       | 0.07754 | 6060.24929 | - | 68.907592 | 51 | 0.048035 |
| Hoxa11   |       | 0.04616 | 3392.109437 | - | 50.732684 | 53 | 0.562929 |
| Hoxa13   |       | 0.0155 | 2581.109752 | - | 53.51514 | 53 | 0.454368 |
| Hoxb1    |       | 0.12032 | 6234.213766 | - | 97.26939 | 53 | 0.000202 |
| Hoxb2    |       | 0.20089 | 7630.718147 | - | 74.329654 | 51 | 0.028202 |
| Hoxb3    |       | 0.0682 | 6804.491332 | - | 110.27395 | 51 | 2.99E-06 |
| Hoxb4    |       | 0.07833 | 2782.655337 | - | 57.138408 | 49 | 0.198478 |
| Hoxb5    |       | 0.04112 | 2579.845633 | - | 52.58684 | 51 | 0.412382 |
| Hoxb6    |       | 0.03218 | 2999.820039 | - | 84.948162 | 53 | 0.003493 |
| Hoxb7    |       | 0.08467 | 2830.916939 | - | 46.602752 | 53 | 0.719984 |
| Hoxb8    |       | 0.04004 | 2402.740558 | - | 67.757986 | 49 | 0.039088 |
| Hoxb9    |       | 0.07068 | 2396.36351 | - | 64.193832 | 51 | 0.101522 |
| Hoxb10   |       | 0.0932 | 5406.206654 | - | 80.769248 | 53 | 0.00315 |
| Hoxb13   |       | 0.07064 | 2170.920406 | - | 41.540226 | 49 | 0.766477 |
| Hoxc4    |       | 0.10072 | 1750.896785 | - | 50.6796 | 51 | 0.486313 |
| Hoxc5    |       | 0.01661 | 1827.959542 | - | 23.769784 | 51 | 0.999598 |
| Hoxc6    |       | 0.024 | 1866.130626 | - | 44.012204 | 49 | 0.675099 |
| Hoxc8    |       | 0.01449 | 2216.008424 | - | 34.485182 | 51 | 0.963032 |
| Hoxc9    |       | 0.10124 | 3753.924295 | - | 61.990646 | 52 | 0.161679 |
| Hoxc10   |       | 0.04165 | 3590.824608 | - | 58.260628 | 53 | 0.287992 |
| Hoxc12   |       | 0.03572 | 3692.162557 | - | 59.774452 | 49 | 0.139236 |
| Hoxc13   |       | 0.01855 | 3752.850376 | - | 57.348828 | 49 | 0.193184 |
| Hoxd1    |       | 0.13913 | 7337.020964 | - | 85.486266 | 53 | 0.003112 |
| Hoxd3    |       | 0.06386 | 6218.339678 | - | 137.330584 | 53 | 2.07E-09 |
| Hoxd4    |       | 0.0646 | 4485.551914 | - | 62.522096 | 53 | 0.173983 |
| Hoxd8    |       | 0.1348 | 3149.132453 | - | 57.04469 | 51 | 0.260494 |
| Hoxd9    |       | 0.07639 | 3097.579436 | - | 88.334012 | 51 | 0.000918 |
| Hoxd10   |       | 0.08759 | 2981.789559 | - | 57.755324 | 53 | 0.303946 |
| Hoxd11   |       | 0.01836 | 1512.864515 | - | 30.639238 | 51 | 0.98937 |
| Hoxd12   |       | 0.0965 | 5210.424758 | - | 63.937927 | 51 | 0.105418 |
| Hoxd13   |       | 0.01608 | 2585.830293 | - | 60.171678 | 53 | 0.232226 |

| Regular factors |     |     |     |     |     |     |
|-----------------|-----|-----|-----|-----|-----|-----|
| BMI1            | 3.880.00777 | 0.5905 | 3808.706323 | - | 142.6025 | 53 | 3.80E-10 |
| E2F6            | 6253.466613 | 0.12074 | 6183.366735 | - | 140.1998 | 53 | 8.26E-10 |
| MLL             | 41867.47573 | 0.12137 | 41805.19744 | - | 124.5566 | 53 | 1.08E-07 |

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**Table S4** The parameters of selective pressure for *Hox* genes and *E2f6* among mammals by branch-site models

| Gene       | Models                      | -lnL       | 2ΔlnL     | P values       | Corrective p | Foreground ω |
|------------|-----------------------------|------------|-----------|----------------|---------------|---------------|
| **Branch-site models** |                             |            |           |                |               |               |
| Hoxa2      | Terminal branch of Killer whale Null | 4222.597508 |           |                |              |               |
|            | Alternative                 | 4216.189169 | 12.816678 | 0.000344       | 0.014772      |               |
| Hoxb2      | Terminal branch of Little brown bat Null | 7528.180049 |           |                |              |               |
|            | Alternative                 | 7515.972378 | 24.41534  | 0.000001       | 0.000034      |               |
| Hoxb3      | Terminal branch of Baiji    Null | 6636.973254 |           |                |              |               |
|            | Alternative                 | 6611.310734 | 51.32504  | <<0.0001       |              |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Little brown bat Null | 6627.499452 |           |                |              |               |
|            | Alternative                 | 6609.69287  | 35.613164 | <<0.0001       |              |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Giant panda Null | 6643.340979 |           |                |              |               |
|            | Alternative                 | 6626.514778 | 33.652402 | <<0.0001       |              |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Elephant Null | 6643.673152 |           |                |              |               |
|            | Alternative                 | 6633.659917 | 20.02647  | <<0.0001       |              |               |
| Hoxd1      | Terminal branch of Little brown bat Null | 7293.998357 |           |                |              |               |
|            | Alternative                 | 7287.529530 | 12.93765  | 0.000322       | 0.016236      |               |
| Hoxd3      | Terminal branch of Minke whale Null | 6165.991917 |           |                |              |               |
|            | Alternative                 | 6161.51464  | 8.95464   | 0.002768       | 0.040594      |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Cat Null | 6170.362654 |           |                |              |               |
|            | Alternative                 | 6165.64571  | 9.433886  | 0.002130       | 0.040594      |               |
| Hoxd8      | Terminal branch of Rabbit Null | 3145.02658  |           |                |              |               |
|            | Alternative                 | 3138.728578 | 12.59599  | 0.000387       | 0.016236      |               |
| Hoxd10     | Terminal branch of Bowhead whale Null | 2982.09969  |           |                |              |               |
|            | Alternative                 | 2972.687661 | 18.82406  | 0.000014       | 0.000072      |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Bottlenose dolphins Null | 2981.01113  |           |                |              |               |
|            | Alternative                 | 2975.016449 | 11.98936  | 0.000535       | 0.011236      |               |
| Hoxd12     | Terminal branch of Bottlenose dolphins Null | 5205.61532  |           |                |              |               |
|            | Alternative                 | 5190.149498 | 30.93165  | <<0.0001       |              |               |
|            |                             |            |           |                |               |               |
|            | Terminal branch of Little brown bat Null | 5201.855003 |           |                |              |               |
|            | Alternative                 | 5188.703934 | 26.302138 | <<0.0001       |              |               |
| E2f6       | Terminal branch of Horse Null | 6095.192953 |           |                |              |               |
|            | Alternative                 | 6088.103055 | 14.179796 | 0.000166       | 0.007138      |               |
Table S5 Positively selected sites and quality changes in *Hox* genes and regulatory factors among mammals

| Gene     | Species                          | Sites | BEB \(^{†}\) | AA Change | Qualitative Change \(^{‡}\) | Total |
|----------|----------------------------------|-------|--------------|-----------|-----------------------------|-------|
| Hoxa2    | Killer whale                     | 110   | 0.991**      | P-G       | B, α, H                | 3     |
| Hoxb2    | Little brown bat                 | 178   | 0.978*       | L-S       | N, B, R, F, α, P            | 7     |
|          |                                  | 180   | 0.985*       | E-R       | K, pH, α                | 3     |
|          |                                  | 213   | 0.963*       | A-L       | —                        | —     |
|          |                                  | 219   | 0.998**      | E-S       | P, α, P            | 4     |
| Hoxb3    | Baiji                            | 209   | 0.827        | P-R       | α             | 1     |
|          |                                  | 217   | 0.999**      | L-A       | —                        | —     |
|          |                                  | 219   | 0.998**      | N-C       | N, B, p, E           | 4     |
|          | Little brown bat                 | 297   | 1.000**      | L-C       | R, α             | 2     |
|          |                                  | 299   | 1.000**      | S-Q       | c                        | 1     |
| Giant panda |                                | 61    | 0.821        | A-H       | —                        | —     |
|          |                                  | 151   | 0.845        | E-P       | P, α, K, α, P          | 5     |
| Elephant |                                  | 152   | 0.893        | G-T       | —                        | —     |
|          |                                  | 153   | 0.998**      | C-T       | N             | 1     |
| Hoxd1    | Little brown bat                 | 145   | 0.897        | L-A       | —                        | —     |
|          |                                  | 167   | 0.981*       | E-S       | P, α, P            | 4     |
| Hoxb4    | Ancestor node of Primates/cow    | 236   | 0.984*       | A-S       | P, α                | 3     |
|          | Ying fox/Hedgehog/Manatee        | 236   | 0.984*       | A-T       | P             | 1     |
| Hoxc4    | Galago/Rabbit/Finless porpoises  | 256   | 0.981*       | Q-P       | P, c, α, m, H          | 4     |
|          | Little brown bat                 | 256   | 0.981*       | Q-H       | —                        | —     |
| Elephant | Galago/Rabbit/Seal/Horse         | 179   | 0.987*       | S-G       | —                        | —     |
|          | Hedgehog/Manatee/Armadillo       |       |              |           |                           |       |
| Hoxc10   | Ancestor node of Pinnipeds       | 212   | 0.924        | N-S       | —                        | —     |
|          | Rabbit/Manatee/Manatee           |       |              |           |                           |       |
|          | Ancestor node of Anthropoid      | 237   | 0.820        | T-A       | P             | 1     |
|          | Little brown bat/Hedgehog        |       |              |           |                           |       |
|          | Manatee                         | 237   | 0.820        | T-I       | N, B, p, K, α, R, H, H   | 6     |
| Hoxd3    | Minke whale                      | 278   | 0.918        | G-A       | P, P             | 2     |
|          |                                  | 397   | 0.999**      | G-L       | B, R, F, P            | 4     |
|          |                                  | 398   | 0.923        | N-S       | —                        | —     |
|          | Cat                              | 126   | 0.994**      | L-C       | R, c, α             | 3     |
|          | Sloth                            | 153   | 0.997**      | S-L       | N, B, R, F, α, P       | 7     |
|          |                                  | 173   | 0.998**      | Q-H       | —                        | —     |
|          |                                  | 175   | 0.998**      | N-T       | —                        | —     |
| Hoxd8    | Rabbit                           | 239   | 0.950*       | D-L       | N, R, e, h, F, P, p, α, α, H, E, P | 12    |
| Hoxd10   | Bowhead whale                    | 321   | 0.964*       | L-M       | —                        | —     |
|          | Bottlenose dolphins              | 326   | 0.949        | R-L       | —                        | —     |
|          |                                  | 9     | 0.996**      | A-N       | P, P            | 2     |

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| Gene      | Species                        | Sites | BEB \(^1\) | AA Change | Qualitative Change \(^2\) | Total |
|-----------|--------------------------------|-------|------------|-----------|--------------------------|-------|
| Hoxd12    | Bottlenose dolphins            | 114   | 0.972*     | R-L       | N\(_i\) B\(_i\) R\(_i\) h pH\(_i\) H\(_{nc}\) p α\(_{nc}\) E\(_{sm}\) E\(_{i}\) | 10    |
|           |                                | 157   | 0.970*     | P-T       | K\(_{ah}\) H\(_i\)          | 2     |
|           |                                | 193   | 0.946      | L-K       | N\(_i\) B\(_i\) R\(_i\) h E\(_i\) F H\(_{nc}\) P\(_{nc}\) p R\(_{nc}\) H\(_{nc}\) E\(_{i}\) | 12    |
|           |                                | 194   | 0.998**    | P-G       | B\(_i\) α\(_i\) H\(_i\)     | 3     |
|           |                                | 197   | 0.904      | A-G       | P\(_{nc}\) P\(_{i}\) P\(_{i}\) | 3     |
|           |                                | 198   | 0.939      | A-G       | P\(_{nc}\) P\(_{i}\) P\(_{i}\) | 3     |
| Little    | brown bat                      | 111   | 0.999**    | E-S       | P\(_{nc}\) P\(_{i}\) α\(_i\) P\(_{i}\) | 4     |
| brown     | bat                            | 112   | 0.998**    | R-V       | N\(_i\) B\(_i\) h pH\(_i\) H\(_{nc}\) p E\(_{sm}\) R\(_{nc}\) E\(_{i}\) | 9     |
| bat       | E2f6                           | 116   | 0.998**    | R-A       | C\(_i\) h pH\(_i\) M\(_{nc}\) H\(_{nc}\) V\(_{sm}\) E\(_{sm}\) E\(_{i}\) | 8     |
| Horse     |                                 | 70    | 0.996**    | Y-L       | α\(_i\) E\(_{sm}\)          | 2     |
| E2f6      |                                 | 73    | 0.997**    | R-S       | C\(_i\) pH\(_i\) V\(_{sm}\) E\(_{sm}\)          | 4     |

\(^1\)Amino acid sites detected by branch-site models with BEB > 0.8 are regarded as candidates for selection. One asterisk is significant and two asterisks are extremely significant.

\(^2\)Radical changes in amino acid properties under category 6-8 derived from TreeSAAP. Amino acid property symbols used: Total non-bonded energy (E\(_i\)), Mean r.m.s. fluctuation displacement (F), Hydrophathy (h), Normalised consensus hydrophobicity (H\(_{nc}\)), Surrounding hydrophobicity (H\(_i\)), Compressibility (K\(_{ah}\)), Polarity (p), Coil tendency (P\(_c\)), Isoelectric point (\(\text{pH}\)), Turn tendency (P\(_t\)), Solvent accessible reduction ratio (R\(_c\)), Chromatographic index (R\(_t\)), Power to be – C-term., α-helix (α\(_i\)), Power to be at the N-terminal (α\(_n\)), Bulkiness (B\(_i\)), Buriedness (B\(_i\)), Composition (c), Helical contact area (C\(_i\)), Long-range non-bonded energy (E\(_i\)) Short- and medium-range non-bonded energy (E\(_{sm}\)), Total non-bonded energy (E\(_i\)), Thermodynamic transfer hydrophobicity (H\(_i\)), Compressibility (K\(_{ah}\)), Molecular weight (M\(_{nc}\)), Average number of surrounding residues (N\(_i\)), Equilibrium constant (ionisation COOH) (pK\(_{a,i}\)), Polar requirement (P\(_r\)), Alpha-helical tendency (P\(_{ah}\)), Partial specific volume (V\(_{sm}\)), Power to be at the C-terminal (α\(_r\)).