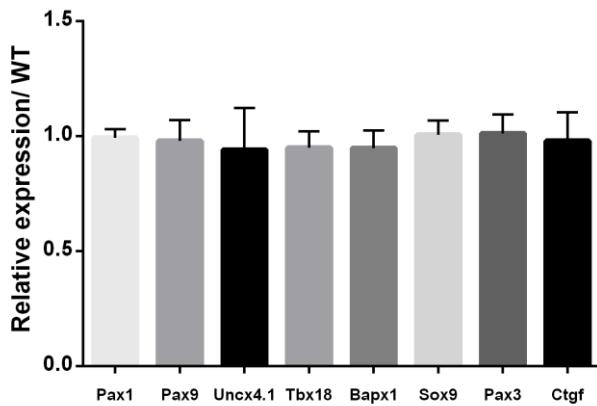
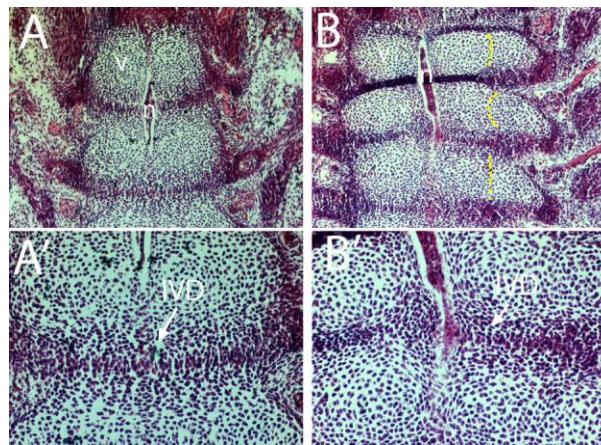


**Fig. S1. Early somite development appears normal in *Fat4*<sup>−/−</sup> and *Dchs1*<sup>−/−</sup> mutants.** Sagittal views of the lumbar and posterior thoracic E10.5 vertebrae showing whole-mount in situ hybridisations for *Pax1*, *Pax9*, *Meox1*, *Meox2* and *Unxc4.1* expression in control (+/+ or +/−) versus *Fat4*<sup>−/−</sup> or *Dchs1*<sup>−/−</sup> mutants.

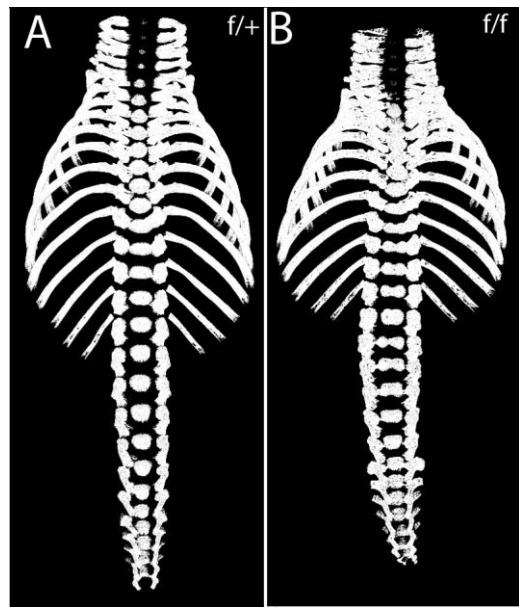


**Fig. S2. Relative gene expression in developing *Fat4*<sup>-/-</sup> and *Dchs1*<sup>-/-</sup> E10.5 somites.** qPCR analysis of relative gene expression in the developing lumbar and posterior thoracic somites of E10.5 *Fat4*<sup>-/-</sup> and *Dchs1*<sup>-/-</sup> mutant mice compared to wildtype/heterozygous littermates.



**Fig. S3. The intervertebral disc forms normally in *Fat4*<sup>-/-</sup> and *Dchs1*<sup>-/-</sup> mutants.**

(A-D), Low (A,B) and high (A',B') power images of H&E stained frontal sections through developing E13 wildtype (A,A') and *Fat4*<sup>-/-</sup> (B, B') lumbar vertebrae and intervertebral discs. The yellow dashed lines in B indicate the edge of the vertebral body. Ivd, intervertebral disc, v, vertebral body.



**Fig. S4. Fat4 is required intrinsically within the mesenchyme for vertebrae development.** MicroCT scanning analysis showing split/butterfly vertebrate in *Dermo1*<sup>Cre</sup>*Fat4*<sup>f/f</sup> P0 (B) but not in control *Dermo1*<sup>Cre</sup> *Fat4*<sup>f/+</sup> P0 (A) mice.

**Table S1. Range of vertebral defects in *Dchs1*<sup>-/-</sup> and *Fat4*<sup>-/-</sup> mice.** Table showing which vertebrae are visually wider in *Dchs1*<sup>-/-</sup> and *Fat4*<sup>-/-</sup> mice (indicated by •) and which are fused across the anterior-posterior axis (indicated by f).

	T 6	T 7	T 8	T 9	T 10	T 11	T 12	T 13	L 1	L 2	L 3	L 4	L 5	L 6
<i>Dchs1</i> <sup>-/-</sup>														
1				•		•	•	•	•	•	•	•	•	
2						•	•	•	•	•	•	•f	•f	
3					•f	•f	•	•	•	•	•	•f	•f	
4					•f	•f	•		•	•	•f	•f		
5				•	•	•	•		•f	•f	•f	•		
6									•	•f	•f	f		
<i>Fat4</i> <sup>-/-</sup>														
1					•	•			•	•	•	•f	•f	
2						•		•		•	•	•		
3	•					•				•	•f	•f	f	
4					•		•				f	•f	f	f
5				•f				•		•	•	•		
6					•	•f	•	•		•	•	•		
7				•f	f		•f		•	•	•	•	•	

**Table S2. Primers used for qPCR analysis of E10.5 somites.** Table listing primer sequence for QPCR (Fig. S2).

Primer	Sequence
<b>Pax9-Fwd</b>	5'TCACGGACATTCTGGGCATC3'
<b>Pax9-Rev</b>	5'CTGTCGCTCACTCCTGGTC3'
<b>Pax3-Fwd</b>	5'GCTGTGGAGACCTCTTACC3'
<b>Pax3-Rev</b>	5'ATCTGACACGGCTTGTGGAA3'
<b>CTGF-Fwd</b>	5'CCCTAGCTGCCTACCGACT3'
<b>CTGF-Rev</b>	5'TGGCTCGCATCATAGTTGGG3'
<b>Pax1-Fwd</b>	5'GGCCATACGAAGCAAGTAAGC3'
<b>Pax1-Rev</b>	5'CCATGAACGCGGGATACTGA3'
<b>Bapx1-Fwd</b>	5'TCCAGGCGATCCTCAACAAGA 3'
<b>Bapx1-Rev</b>	5'GGCTGAGTCTGAGTCCCAC3'
<b>Tbx18-Fwd</b>	5'AGGCCATCACTACGGACTCT3'
<b>Tbx18-Rev</b>	5'GAAGAACTTGTGTTGCCCTGCT3'
<b>Uncx4.1-Fwd</b>	5'CCCCAGACTCCAACGAATC3'
<b>Uncx4.1-Rev</b>	5'CACAGCGTTTCGTTGCCT3'
<b>Sox9-Fwd</b>	5'GCCACGGAACAGACTCACAT3'
<b>Sox9-Rev</b>	5'GGACCCTGAGATTGCCAGA3'
<b>GAPDH-Fwd</b>	5' AGGTCGGTGTGAACGGATTTG3'
<b>GAPDH-Rev</b>	5'TGTAGACCATGTAGTTGAGGTCA 3'