

Title: Supplementary Data 1

Description: Sections metadata and DEG analysis. (Tab 1) Metadata for all sections that passed our quality-control checks. Section, section number; sample, genotype; condition, controls or dystrophic; replicates, biological replicate of origin; batch, sequencing batch; region, anatomical region; uncorrected PC1, uncorrected PCA 1; uncorrected PC2, uncorrected PCA coordinate 2; uncorrected UMAP1, uncorrected UMAP 1; uncorrected UMAP2, uncorrected UMAP coordinate 2; PC1, corrected PCA coordinate 1; PC2, corrected PCA coordinate 2; clusters, assigned cluster. (Tab 2,3) Differentially expressed genes (DEG) detected between DMD and WT (Tab 2) or Ctr and WT (Tab 3). Names, gene name; scores, z-score underlying the computation of a P value for each gene for each group; logfoldchanges, log2 fold change; pvals, uncorrected P value; pvals_adj, adjusted P value. Uncorrected P value and adjusted P value have been obtained as described in the Methods.

Title: Supplementary Data 2

Description: Controls regionalization. (Tab 1) Metadata for all sections that passed our quality-control checks. Section, section number; sample, genotype; condition, controls or dystrophic; replicates, biological replicate of origin; batch, sequencing batch; region, anatomical region; leiden, assigned cluster; annotation, cluster annotation; transcript counts, number of normalized transcripts detected in this section; PC1, PCA coordinate 1; PC2, PCA coordinate 2. (Tab 2) Differentially expressed genes (DEG) detected for each cluster of sections. Central_mean-zscore, mean z-score central sections; Proximal-distal_mean-zscore, mean z-score proximal-distal sections; mean z-score difference, mean z-score difference between central and proximal-distal; p_value, uncorrected P value; adj_p_value, adjusted P value. P value and adjusted P value have been obtained as described in the Methods.

Title: Supplementary Data 3

Description: DMD regionalization. (Tab 1) Metadata for all sections that passed our quality-control checks. Section, section number; sample, genotype; condition, controls or dystrophic; replicates, biological replicate of origin; batch, sequencing batch; region, anatomical region; leiden, assigned cluster; annotation, cluster annotation; transcript counts, number of normalized transcripts detected in this section; PC1, PCA coordinate 1; PC2, PCA coordinate 2. (Tab 2) Differentially expressed genes (DEG) detected for each cluster of sections. Central_mean-zscore, mean z-score central sections; Proximal-distal_mean-zscore, mean z-score proximal-distal sections; mean z-score difference, mean z-score difference between central and proximal-distal; p_value, uncorrected P value; adj_p_value, adjusted P value. P value and adjusted P value have been obtained as described in the Methods.

Title: Supplementary Data 4

Description: Fiber type quantification. Absolute numbers of each fiber type or total number of fibers per region are shown in each cell for TA (Tab 1), EDL (Tab 2) and SOL (Tab 3) muscles.

Title: Supplementary Data 5

Description: Genes with region-specific disease effects. Gene, gene name; pval model, overall model significance; pval, significance of the interaction term; mean_expression_controls_central, mean expression across control central sections; mean_expression_controls_pd, mean expression across control proximal-distal sections; mean_expression_DMD_central, mean expression across DMD central sections; mean_expression_DMD_pd, mean expression across DMD proximal-distal sections;

mean_expression_DMD, mean expression across DMD sections; mean_expression_controls, mean expression across control sections; fdr_pval_model, FDR corrected overall model significance; fdr, FDR corrected significance of the interaction term; log2FC_DMD-central_controls-central, log2 fold change DMD central sections and control central sections; log2FC_DMD-central_controls-pd, log2 fold change DMD central sections and control proximal-distal sections; log2FC_DMD-pd_controls-central, log2 fold change DMD proximal-distal sections and control central sections; log2FC_DMD-pd_controls-pd, log2 fold change DMD proximal-distal sections and proximal-distal central sections; log2FC_DMD_controls, log2 fold change DMD and controls. *P* value and adjusted *P* value have been obtained as described in the Methods.

Title: Supplementary Data 6

Description: Source data for graphs and charts. Source Data for Figs. 1, 2, 4-6 and Figs. S1, S4, S5, S10, S11.