Here is some help with the proof of Thm 2.2.3, that det $AB = \det A \det B$. One step I did not explain thoroughly in class was this - If A is singular, then AB is singular. If we were talking about BA, this would be a HW problem from Ch 1.5, but with the A on the left, we need more work. Here is is -

Proof: Assume A is singular. Then det A = 0 (Thm 2.2.2). Then det $A^T = 0$ too (Thm 2.1.2). So, A^T is singular (Thm 2.2.2). So, $B^T A^T$ is singular (your HW, since A^T is on the right). So, $(AB)^T$ is singular (same matrix, by matrix algebra). So, (AB) is singular (repeat the reasoning used to show A^T was singular). Done.

NOTE: If you prefer, you can follow the proof in the book of Thm 2.2.3. It does not directly use the reasoning above because it splits B into elementary's instead of A. However, this must be explained somewhere, so it is not really a shorter proof than ours. The explanation appears in the box on page 94 (halfway down). In my opinion, this is part of the textbook proof of 2.2.3 and you should include it in your proof, if this appears on a Quiz.