5.4 No. For example, consider $A = \{0^n1^n \mid n = 0, 1, 2, 3, \ldots\}$ and let f be the function that maps 0^n1^n to 1^n and maps all other string to -1. Then f is a mapping reduction from A to 1^*, which is regular even though A is not regular.

5.5 Show that A_{TM} is not mapping reducible to E_{TM}. I will be using the $\neg$ symbol to indicate complement instead of drawing a line over the language. We know that A_{TM} is Turing recognizable, but not co-Turing recognizable. The TM below recognizes $\neg E_{TM}$, so E_{TM} is co-Turing recognizable.

M = "On input <M>, where M is a TM

1. For each i = 1, 2 3, …
    1. Run M on all strings of length i for i steps
    2. If any string is accepted, **accept**"

This Turing machine will accept any Turing machine whose language is non-empty.

Now assume A_{TM} is mapping reducible to E_{TM}. Then $\neg A_{TM}$ is mapping reducible to $\neg E_{TM}$. But, $\neg E_{TM}$ is Turing recognizable and $\neg A_{TM}$ is not, which contradicts Theorem 5.22. This is a contradiction. Therefore, A_{TM} is not mapping reducible to E_{TM}.

5.7 $A \leq_m \neg A$ implies $\neg A \leq_m A$. By Theorem 5.16, we can conclude that $\neg A$ is Turing recognizable since we know A is Turing recognizable. By Theorem 4.16, we can conclude A is decidable since it is both TR and co-TR.

5.3 Let A be any Turing recognizable language and let M be a Turing machine such that L(M) = A. Let f be the function that maps any string w to the string <M.w>. Then w is in A if and only if f(w) is in A_{TM} – i.e., f is a mapping reduction from A to A_{TM}.

6.3 Since $A \leq_T B$, there is a Turing machine M_1 that calls an oracle for B and decides A. Similarly, since $B \leq_T C$, there is a Turing machine M_2 that calls an oracle for C and decides B. Now, consider the Turing machine M that does exactly what M_1 does except instead of calling the oracle for B, it calls M_2. Since M_2 decides B, it will give the same answer as the oracle did, so M will decide A. Also, M_2 uses an oracle for C, so M also uses and oracle for C to decide A. Therefore, $A \leq_T C$.