4 (a) (i) Imidazole is an aromatic heterocycle that has 6 π-electrons in a set of 5 p-orbitals perpendicular to the plane of the ring. The p-orbital on the NH formally contributes 2 electrons to the π-system whereas all the other ring p-orbitals all contribute 1 p-electron each:

![Diagram of Imidazole]

NB. all ring atoms are sp²-hybridized and there a 6π-electrons in the 5 p-orbitals perpendicular to the ring. This fulfills Hückel’s rule [4n+2] where n = 1. The electron contribution to the π-system from each atom is indicated (NB. the electrons are NOT localised).

(ii) There are two nitrogen atoms in imidazole, one is pyrrole-like and the other is pyridine-like (see above).

The pair of electrons on the pyrrole-like nitrogen are located in the p-orbital perpendicular to the plane of the ring and are involved in the aromatic sextet; this makes them unavailable for bonding to a proton and consequently a pyrrole nitrogen is essentially non-basic [cf. pKₐ (pyrrole) -4].

The lone pair of electrons on the pyridine-like nitrogen are located in an sp²-hybrid orbital in the plane of the ring and are NOT involved in the aromatic sextet; this makes them available for bonding to a proton and consequently a pyridine nitrogen is basic [cf. pKₐ (pyridine) 5].

The availability of a lone pair of electrons for bonding to a proton is strongly influenced by the hybridisation state of the orbital in which it is located; the greater the s-character the less availability for bonding as degree of s-orbital character equates with degree of nuclear attraction the electrons experience. For this reason the sp² lone pair of electrons on nitrogen in pyridine (~33% s-character) are less basic than the sp³ lone pair of electrons in triethylamine (~25% s-character, pKₐ 11).

The reason why the imidazole (pKₐ 7) is more basic than pyridine (pKₐ 5) is because protonated imidazole has two resonance forms such that both nitrogens contribute equally in carrying the positive charge:

![Diagram of Resonance Forms]

(b) (i) Condensation reaction. Intermediates are generally not isolated and any reasonable mechanism is acceptable. Elimination of one equivalent of water overall.
(ii) Condensation reaction. Intermediates are generally not isolated and any reasonable mechanism is acceptable. Elimination of two equivalents of water overall.