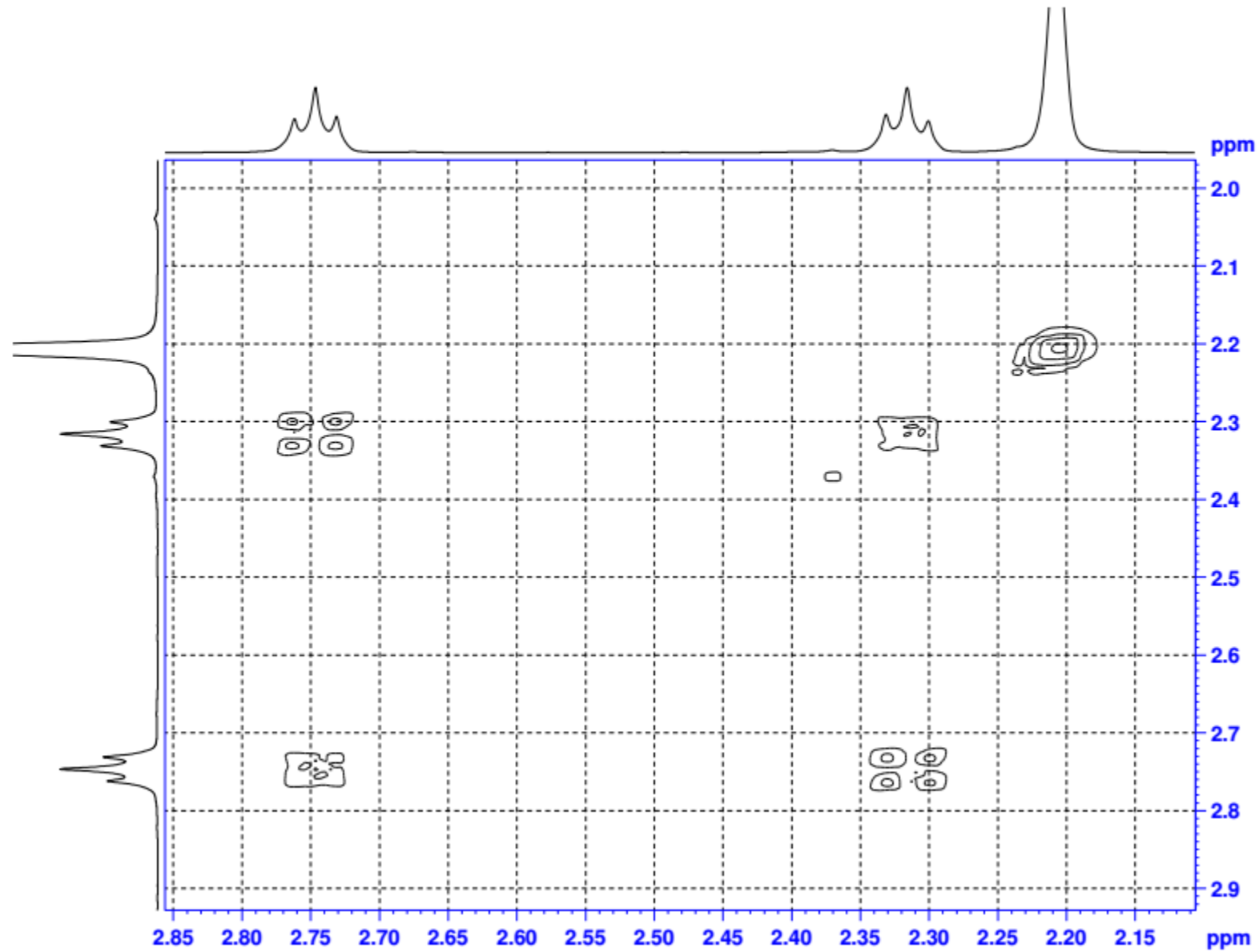
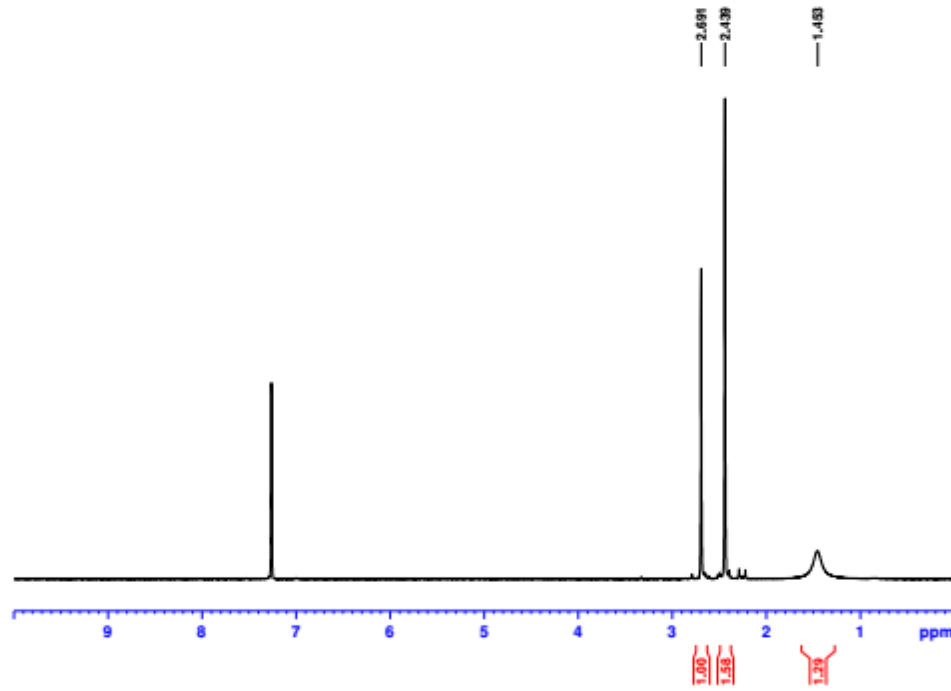


# 2D NMR Spectroscopy

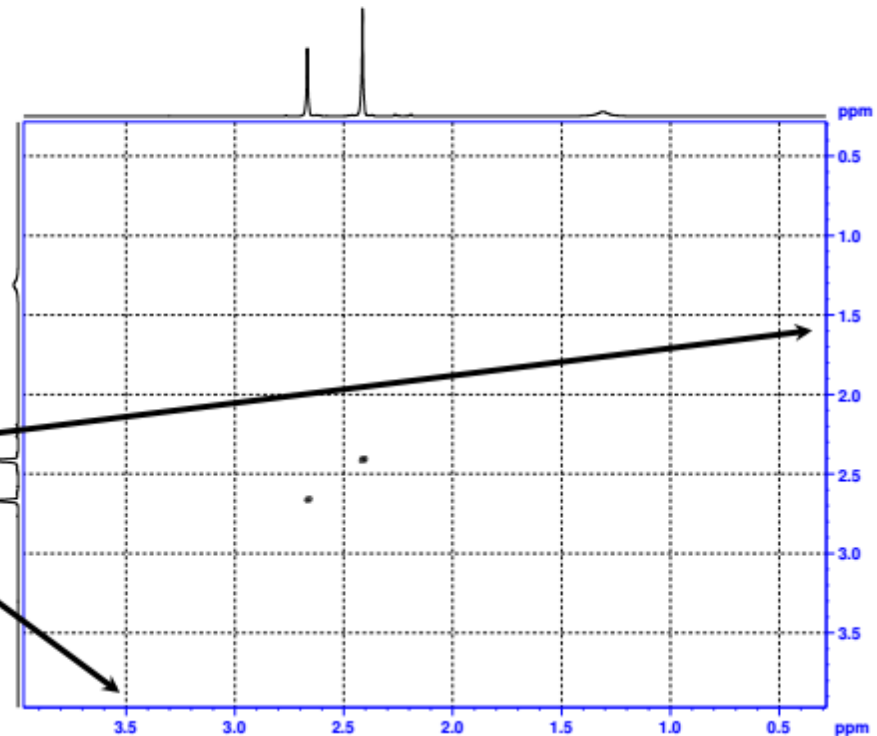


# 2D NMR Spectroscopy

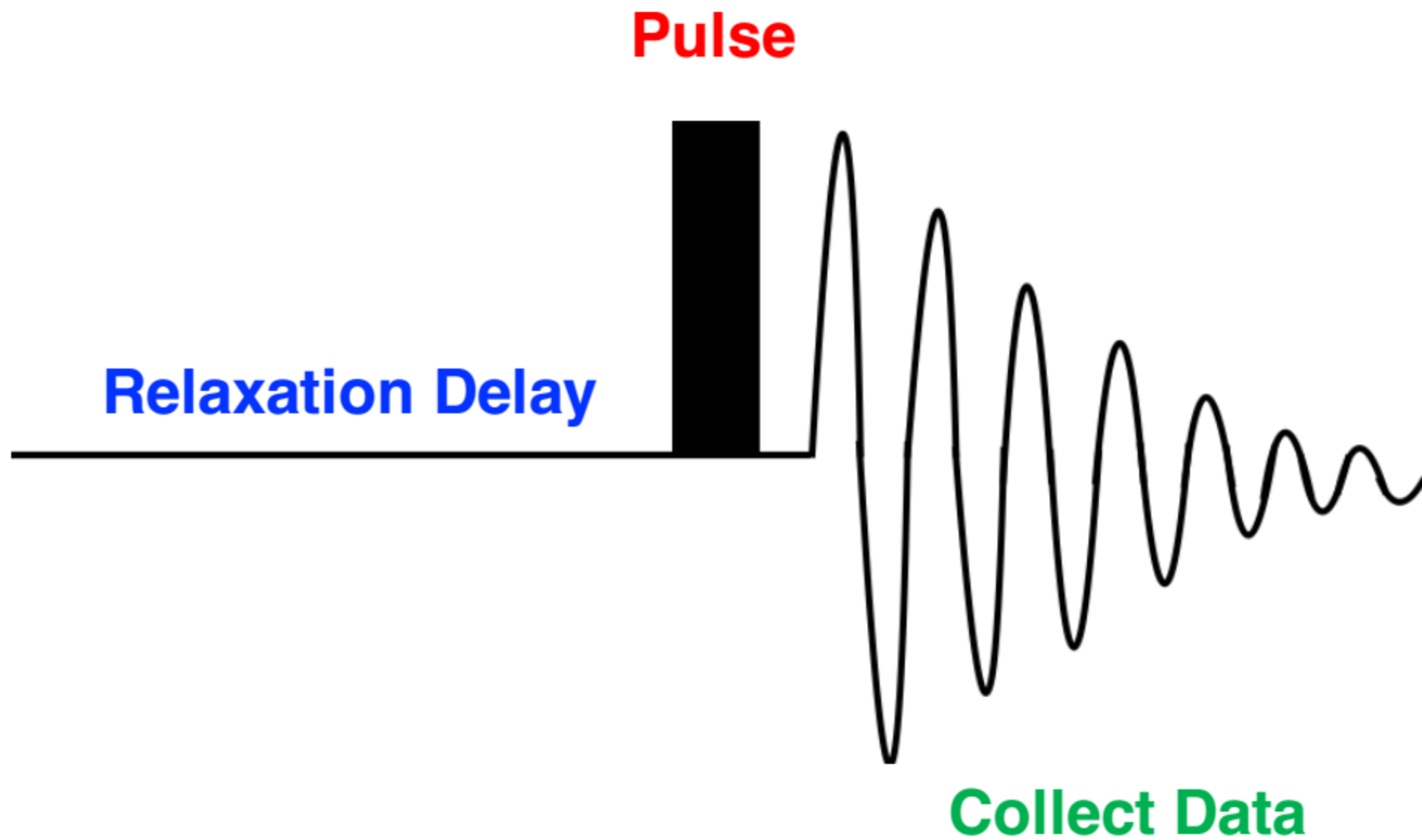


1D NMR spectra  
have one frequency  
dimension

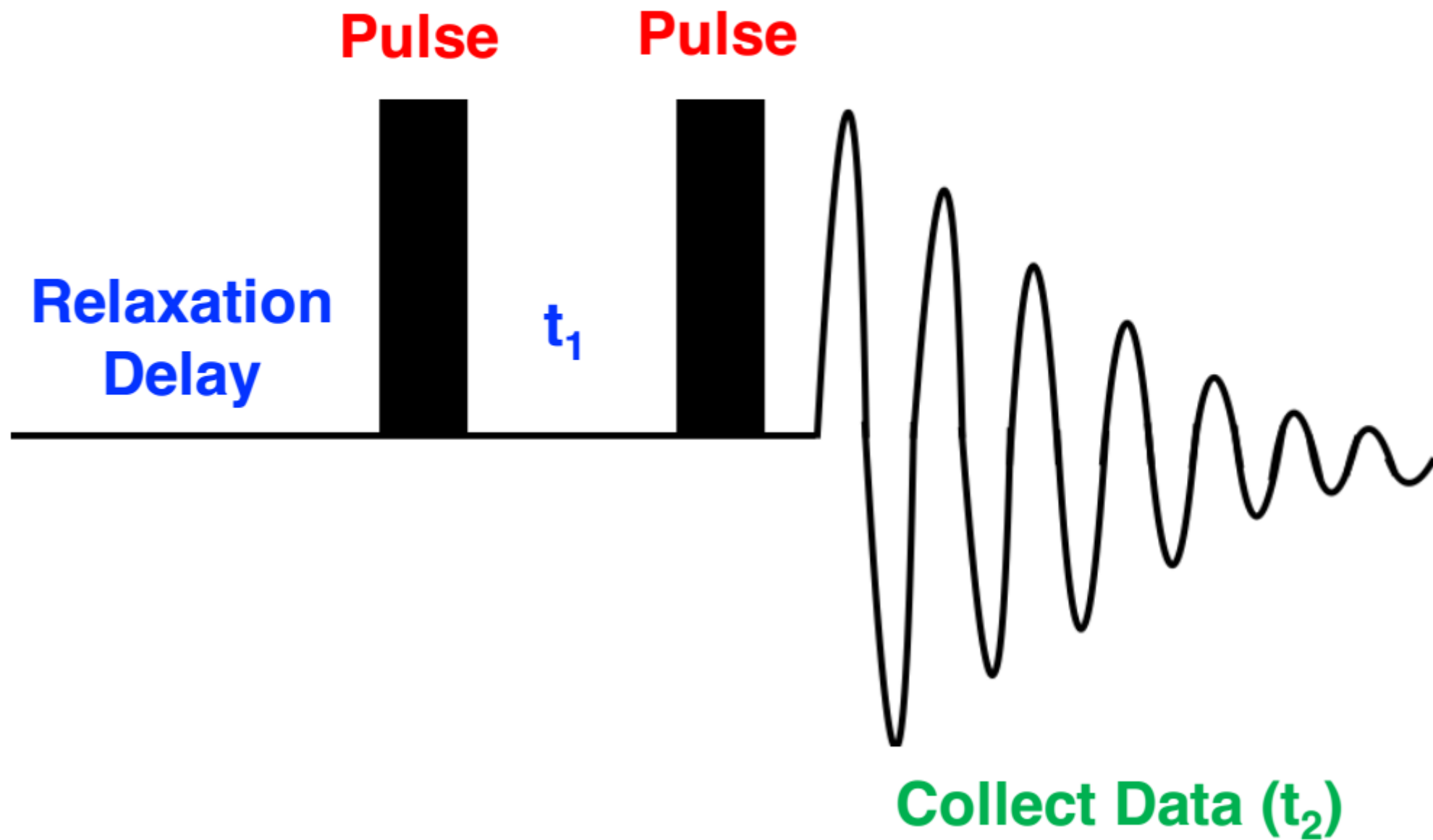
2D NMR spectra  
have two frequency  
dimensions



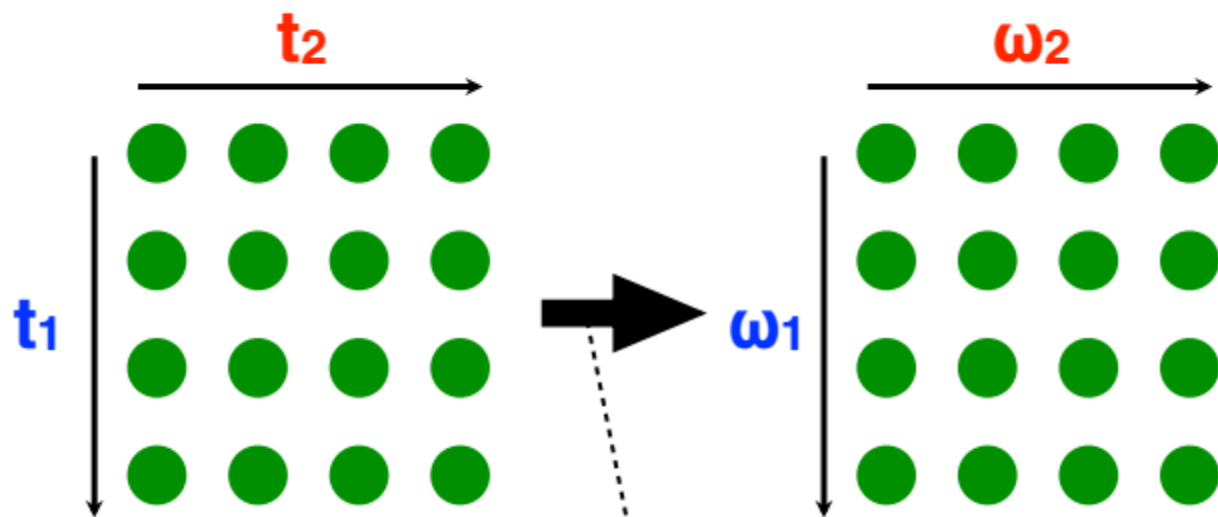
# 1D NMR Pulse Sequences



# 2D NMR Pulse Sequences



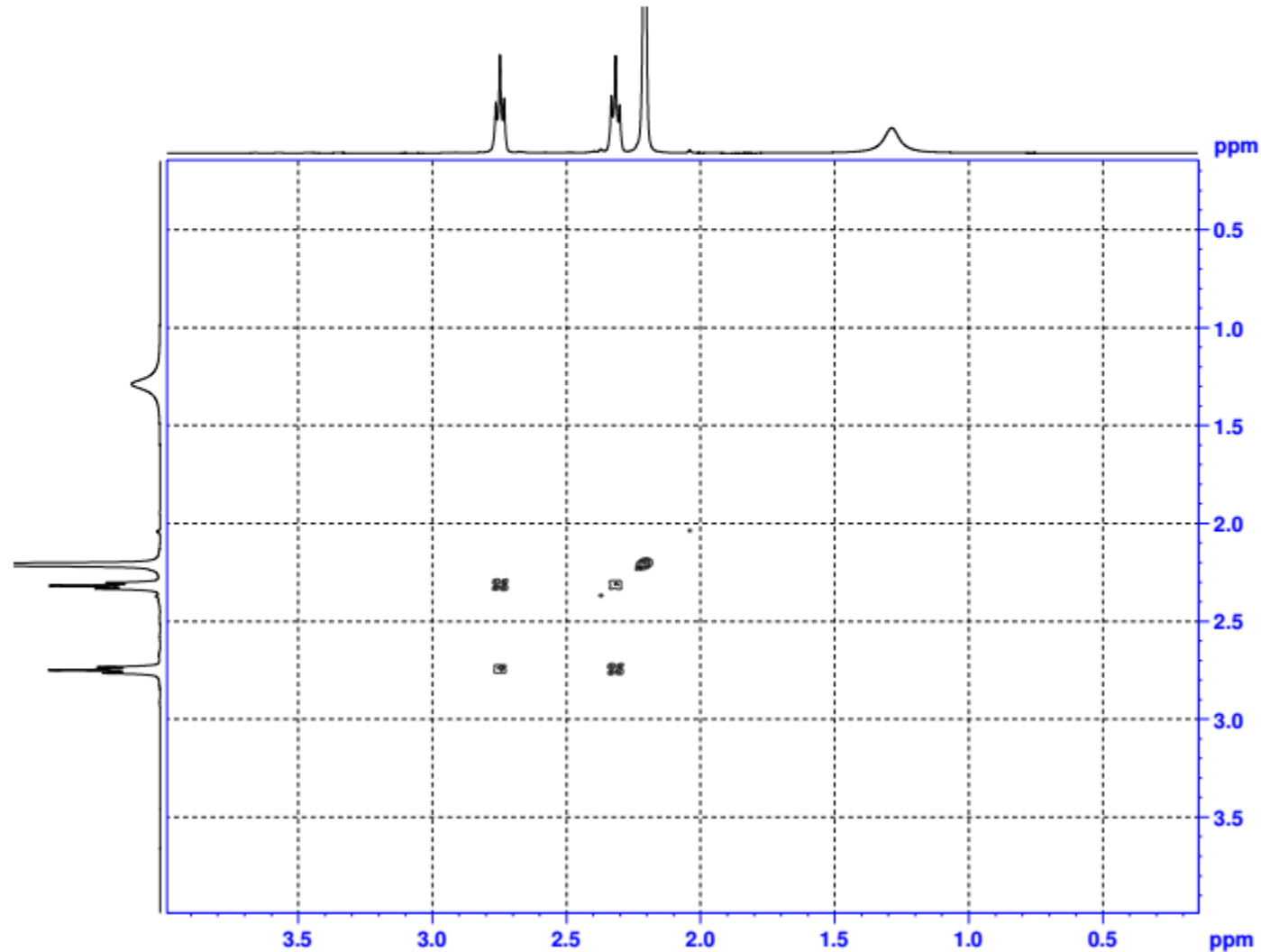
# 2D NMR Experiments



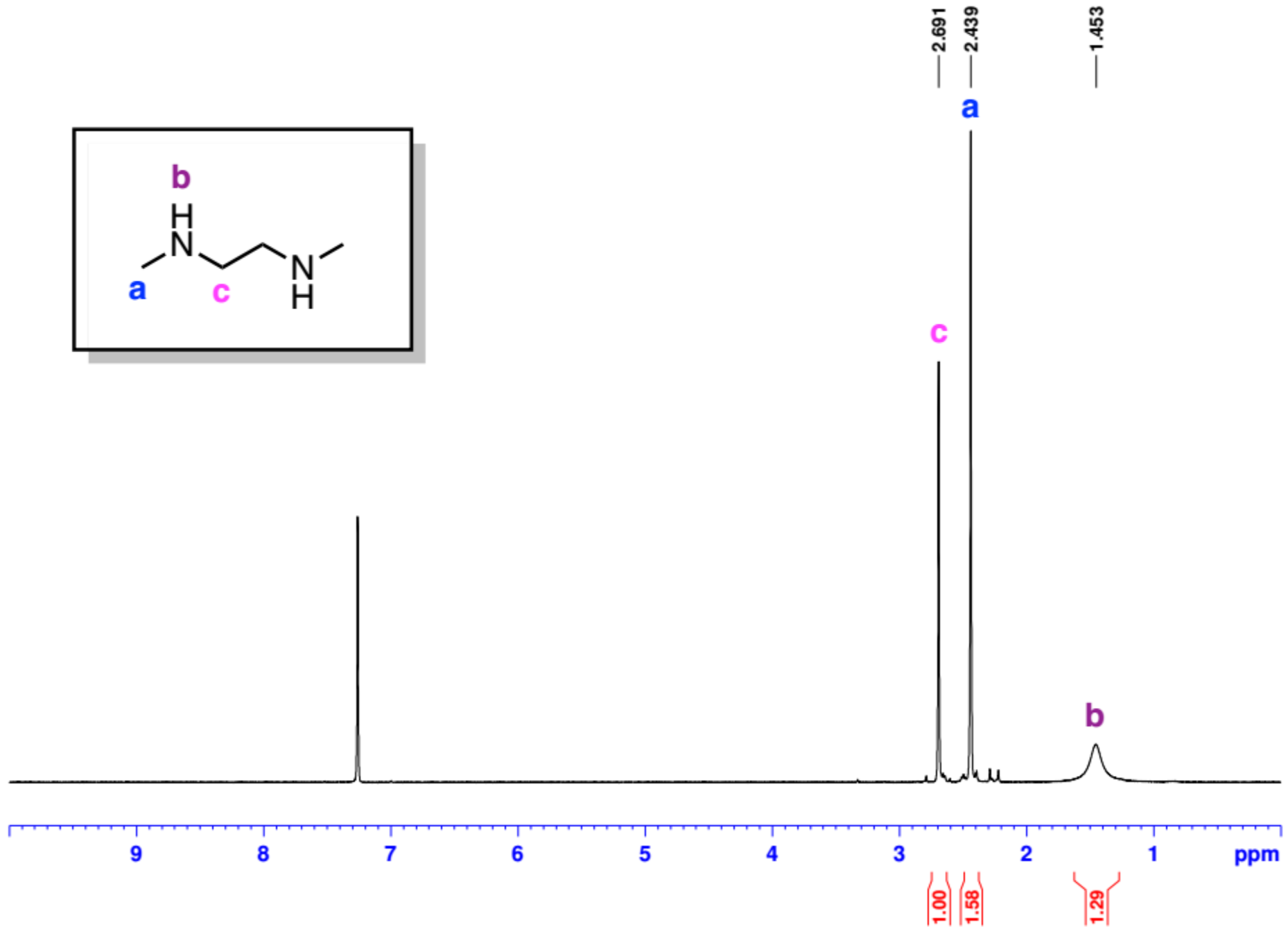
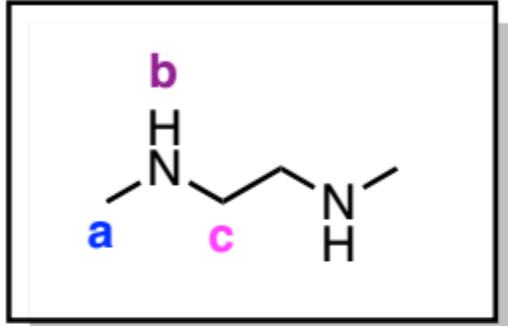
Fourier transformation of the rows followed by the columns gives the final 2D spectrum

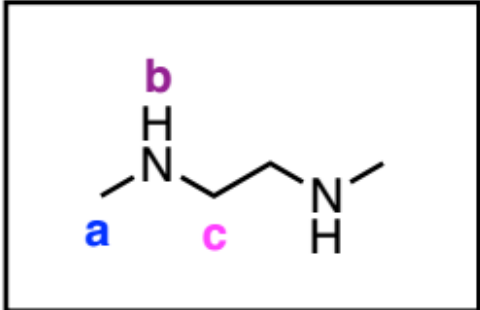
# CORrelation SpectroscopY (COSY)

Shows correlations between protons that are couple to each other



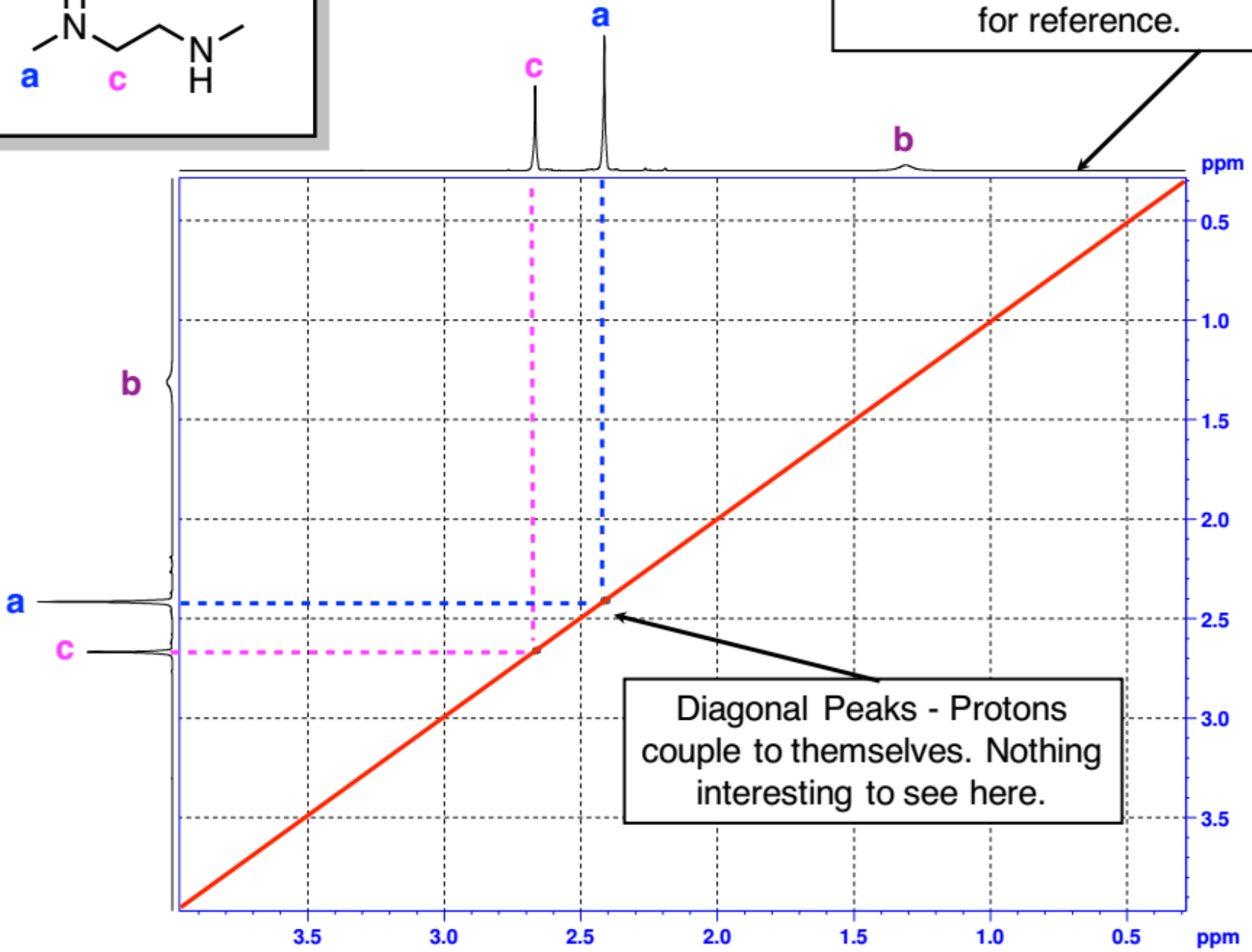
# $^1\text{H}$ NMR





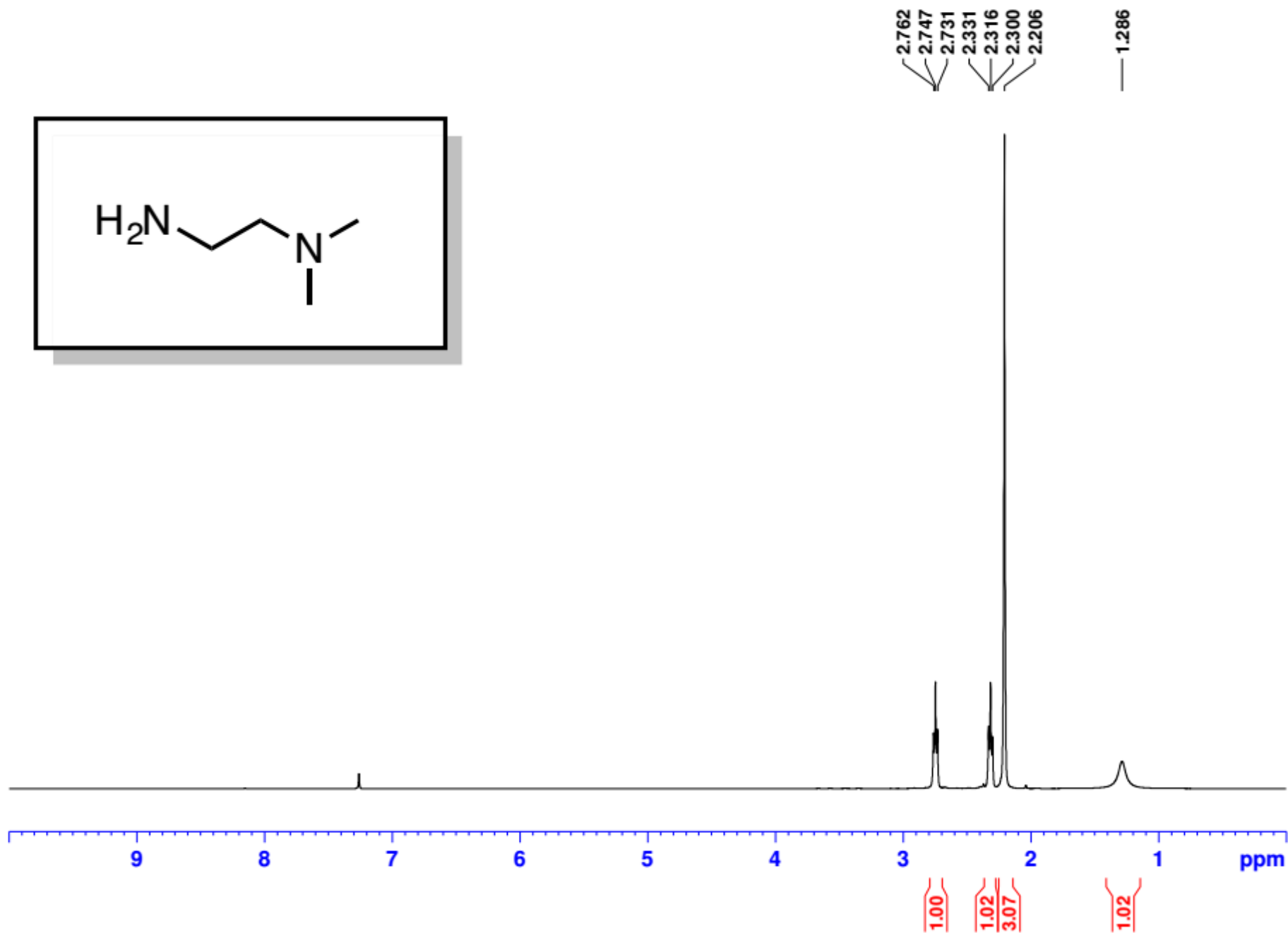
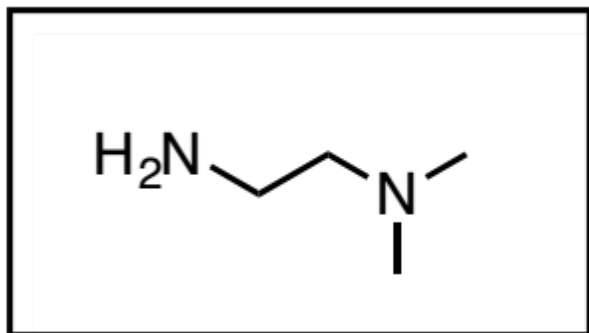
# COSY

1D Curves - Not a part of the experiment. They are added for reference.

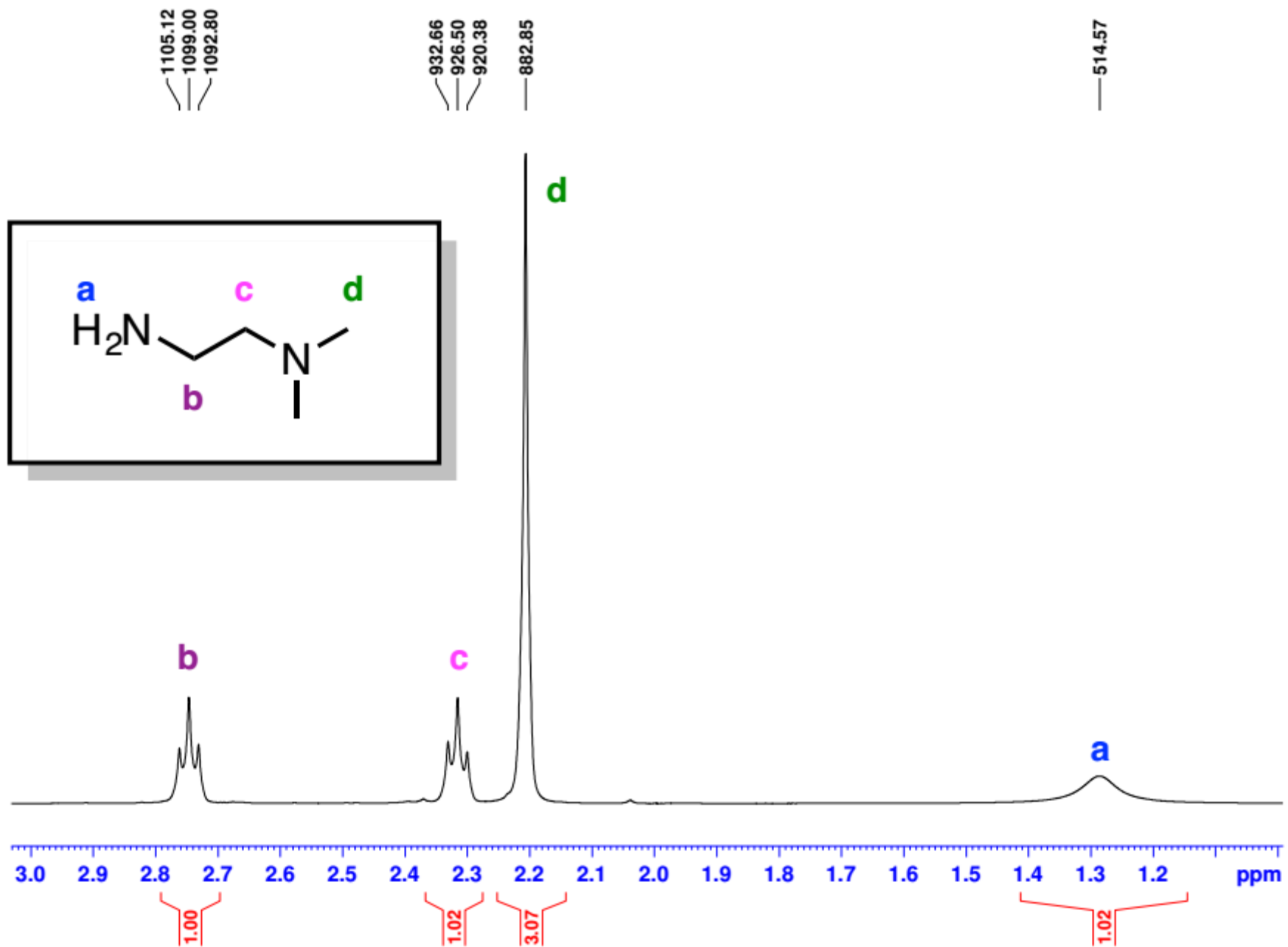


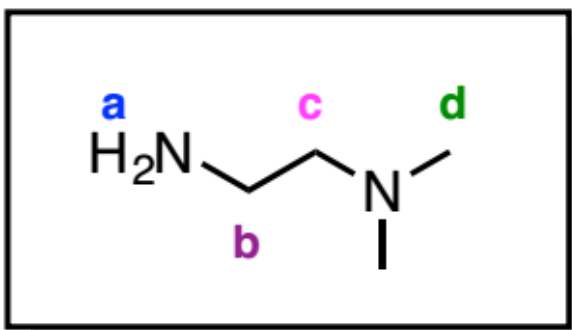


# $^1\text{H}$ NMR

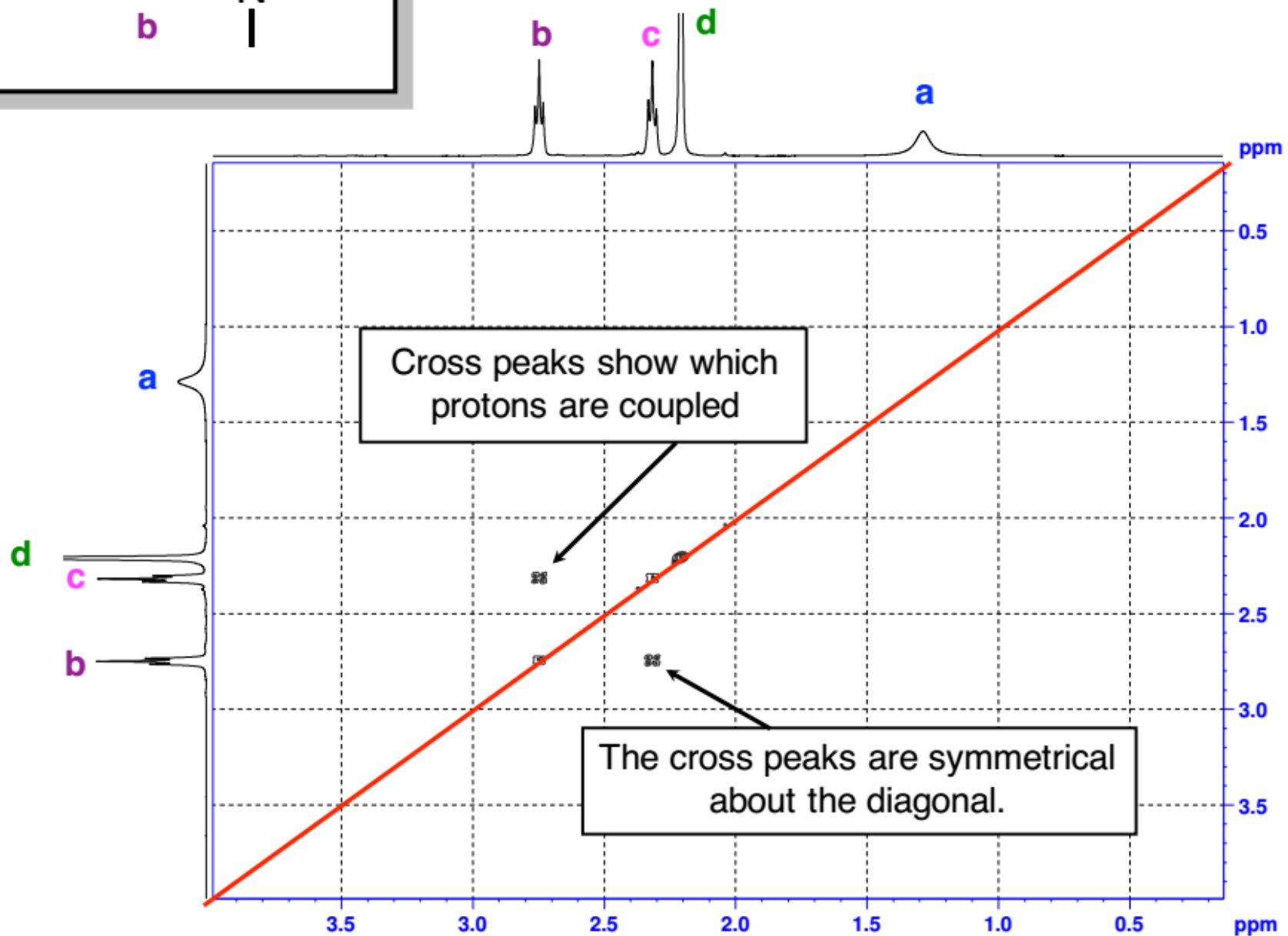


# $^1\text{H}$ NMR

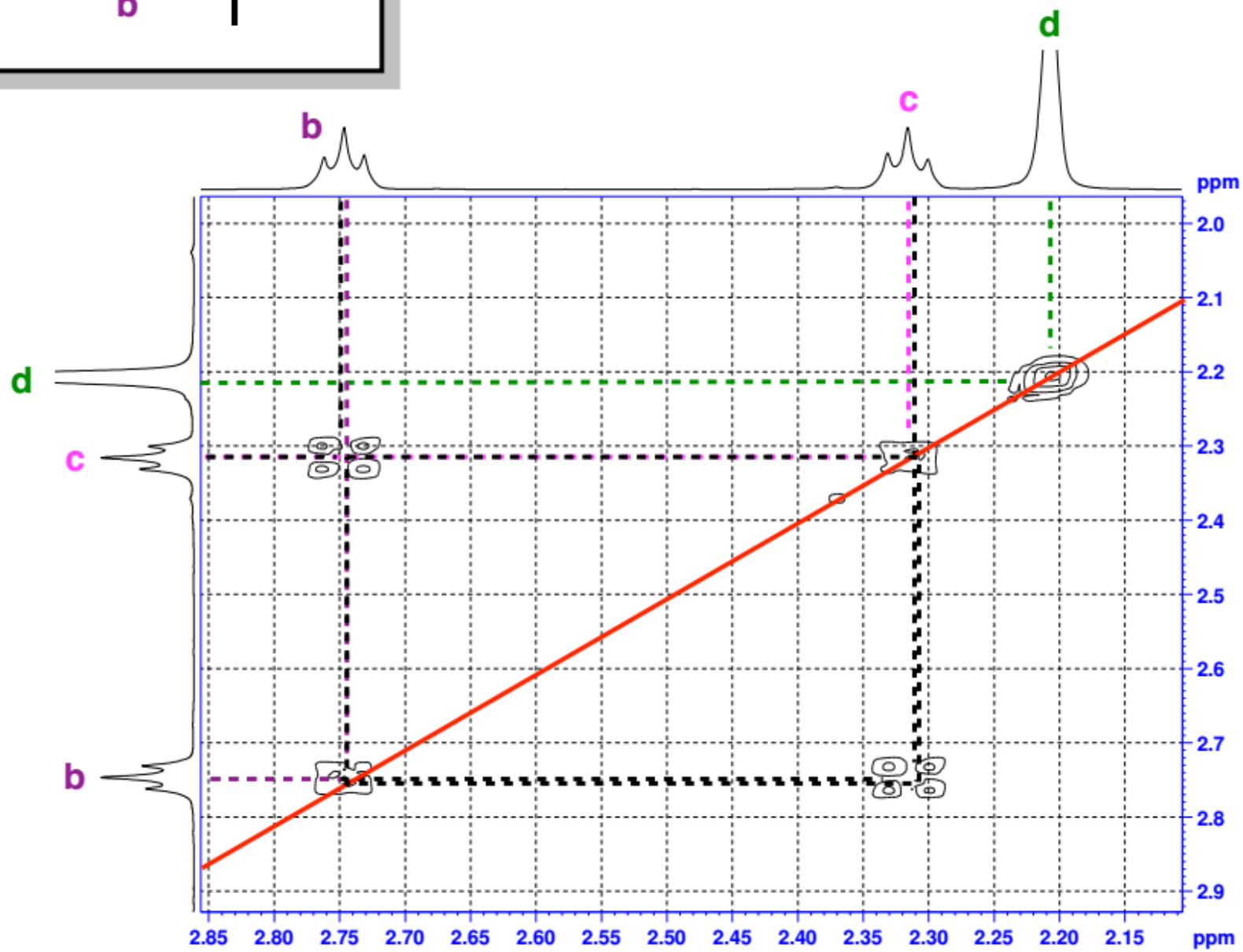
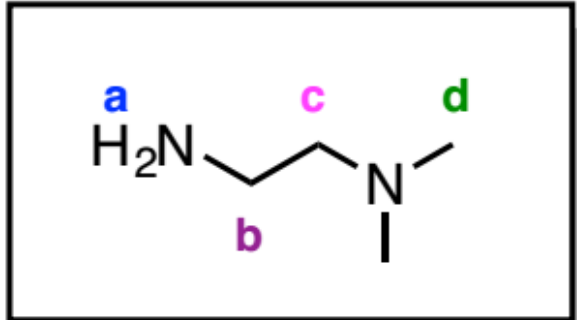




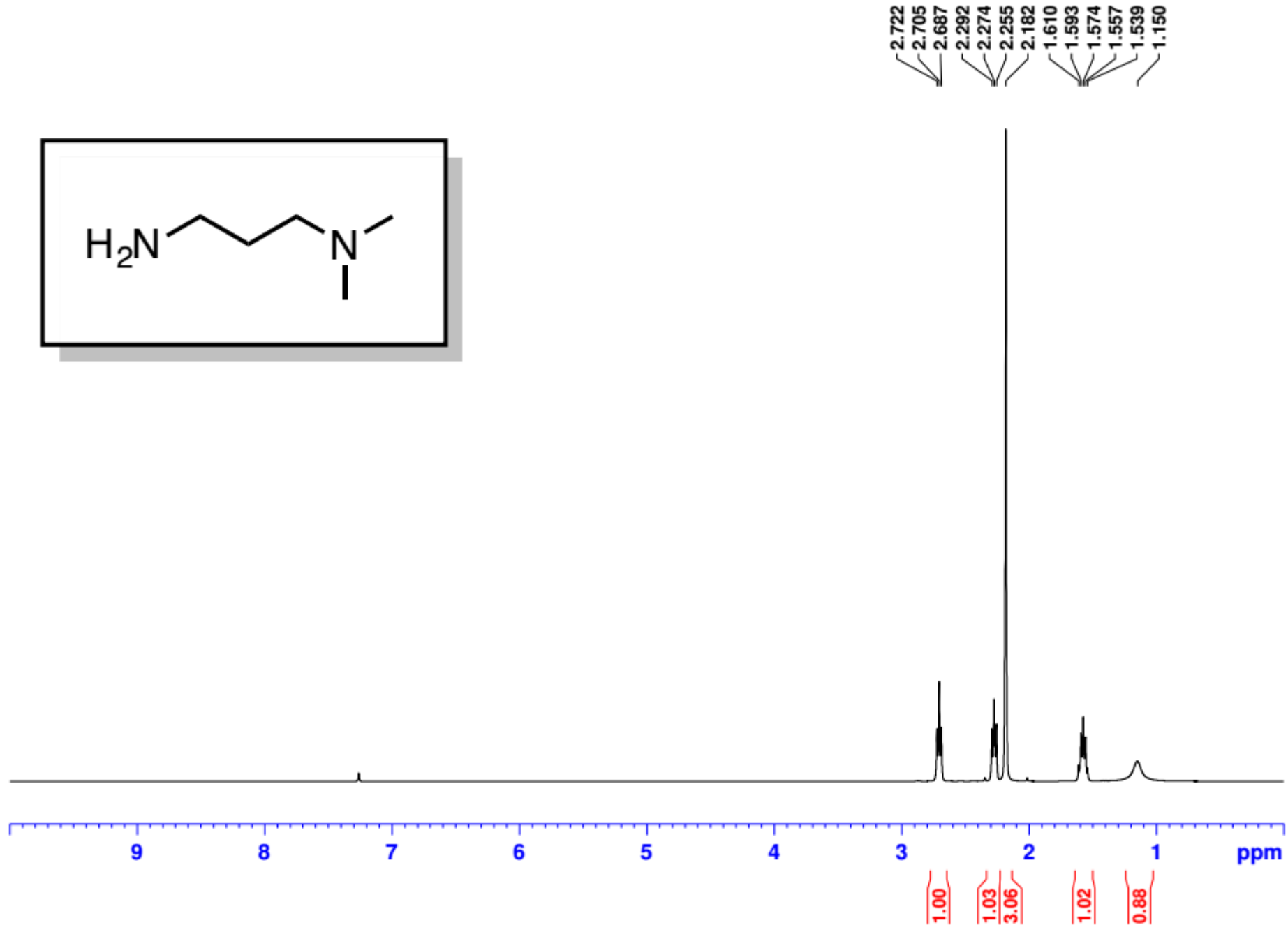
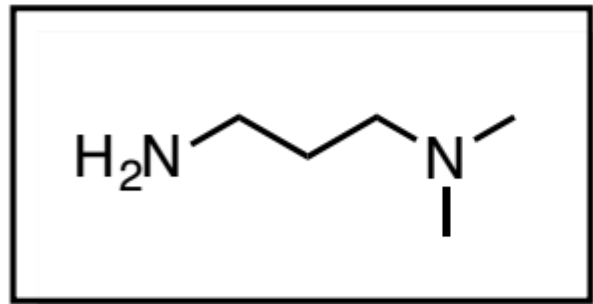
# COSY



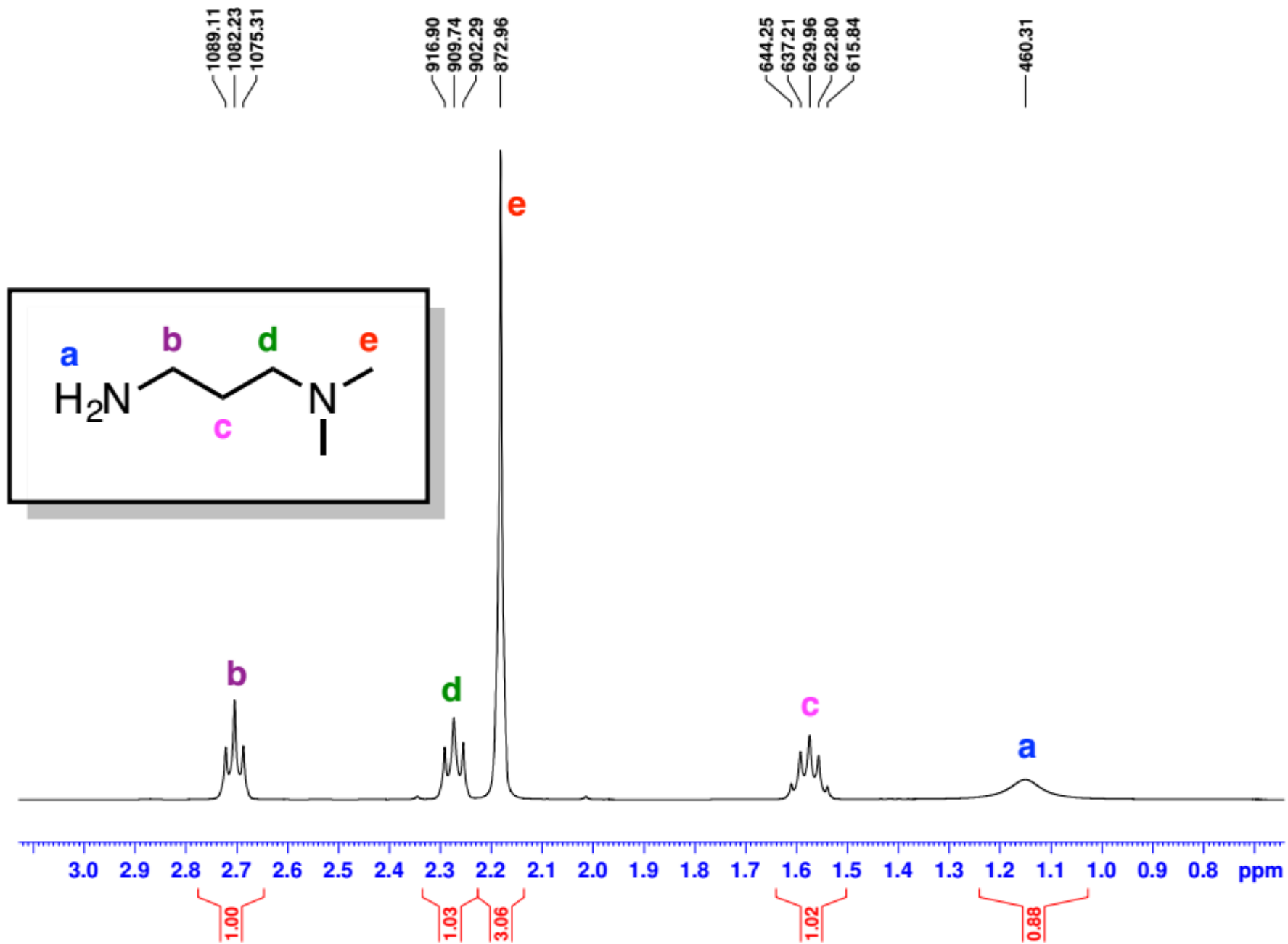
# COSY

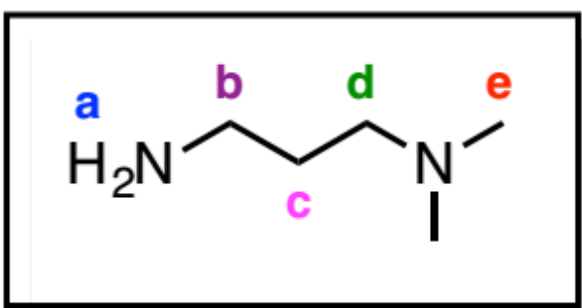


# $^1\text{H}$ NMR

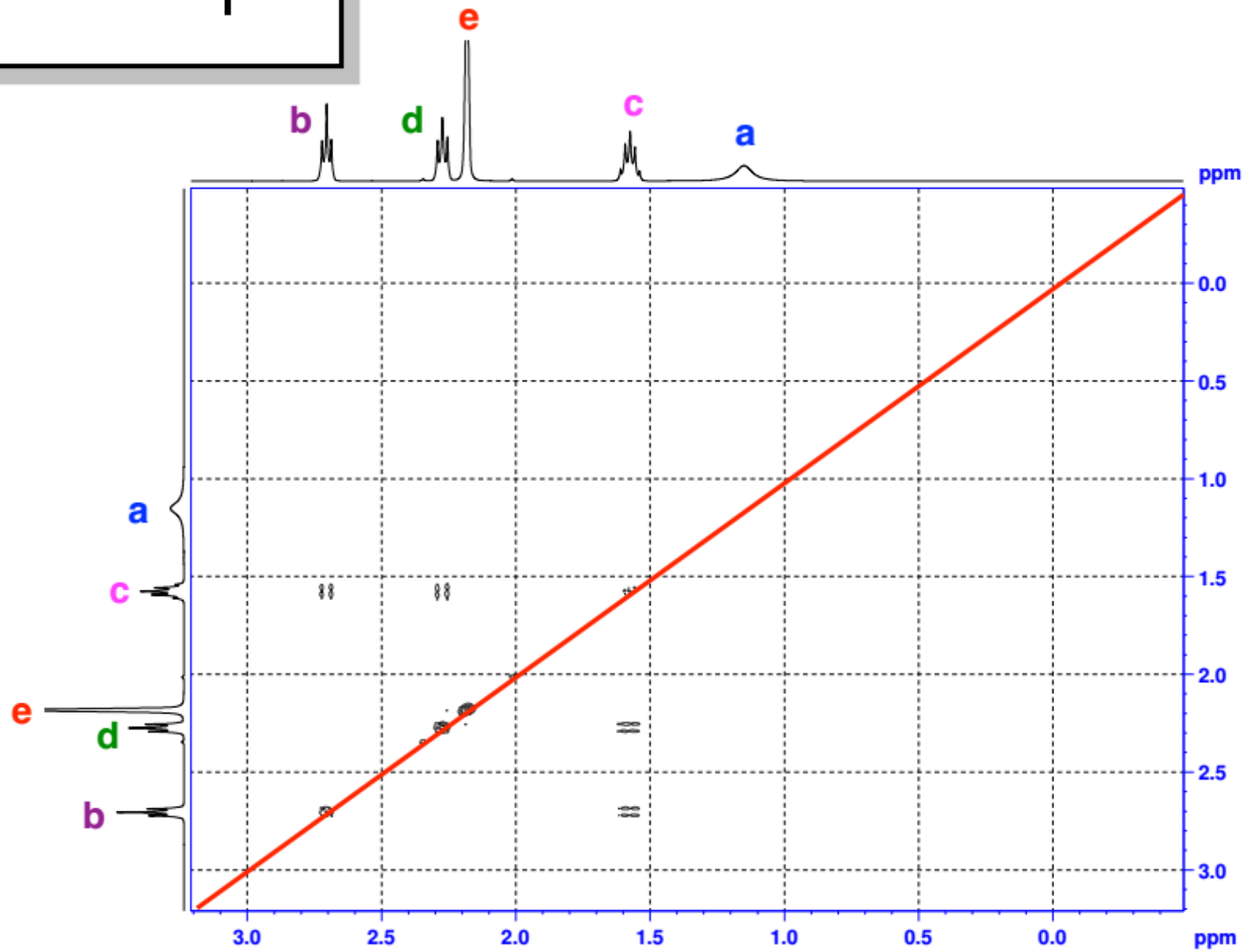


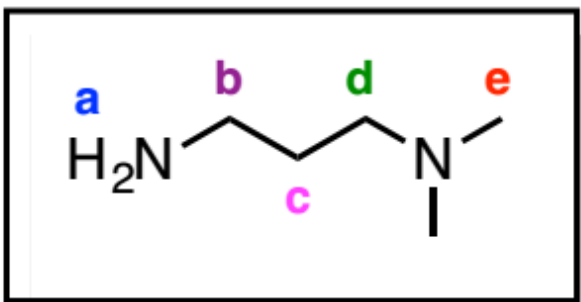
# $^1\text{H}$ NMR



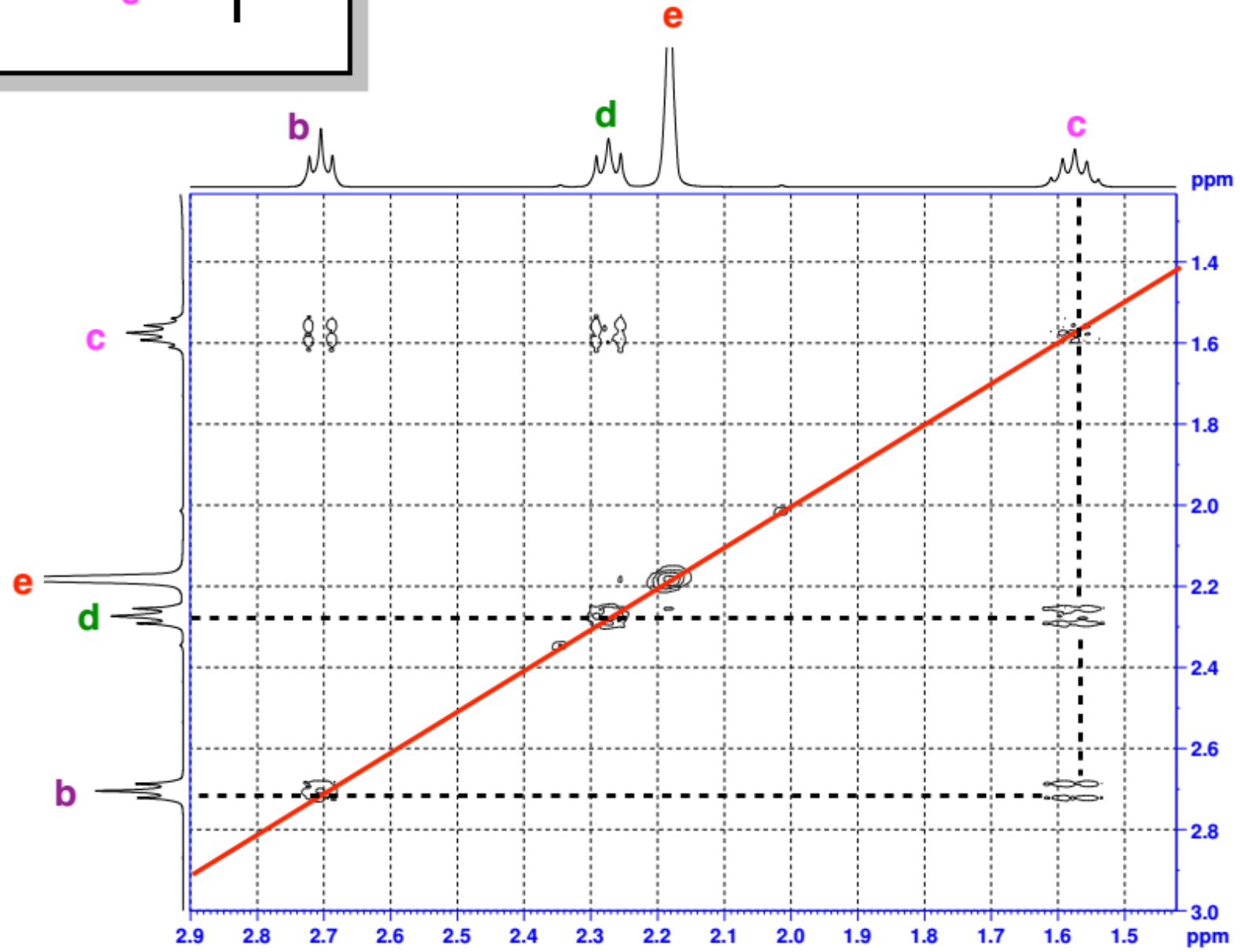


# COSY





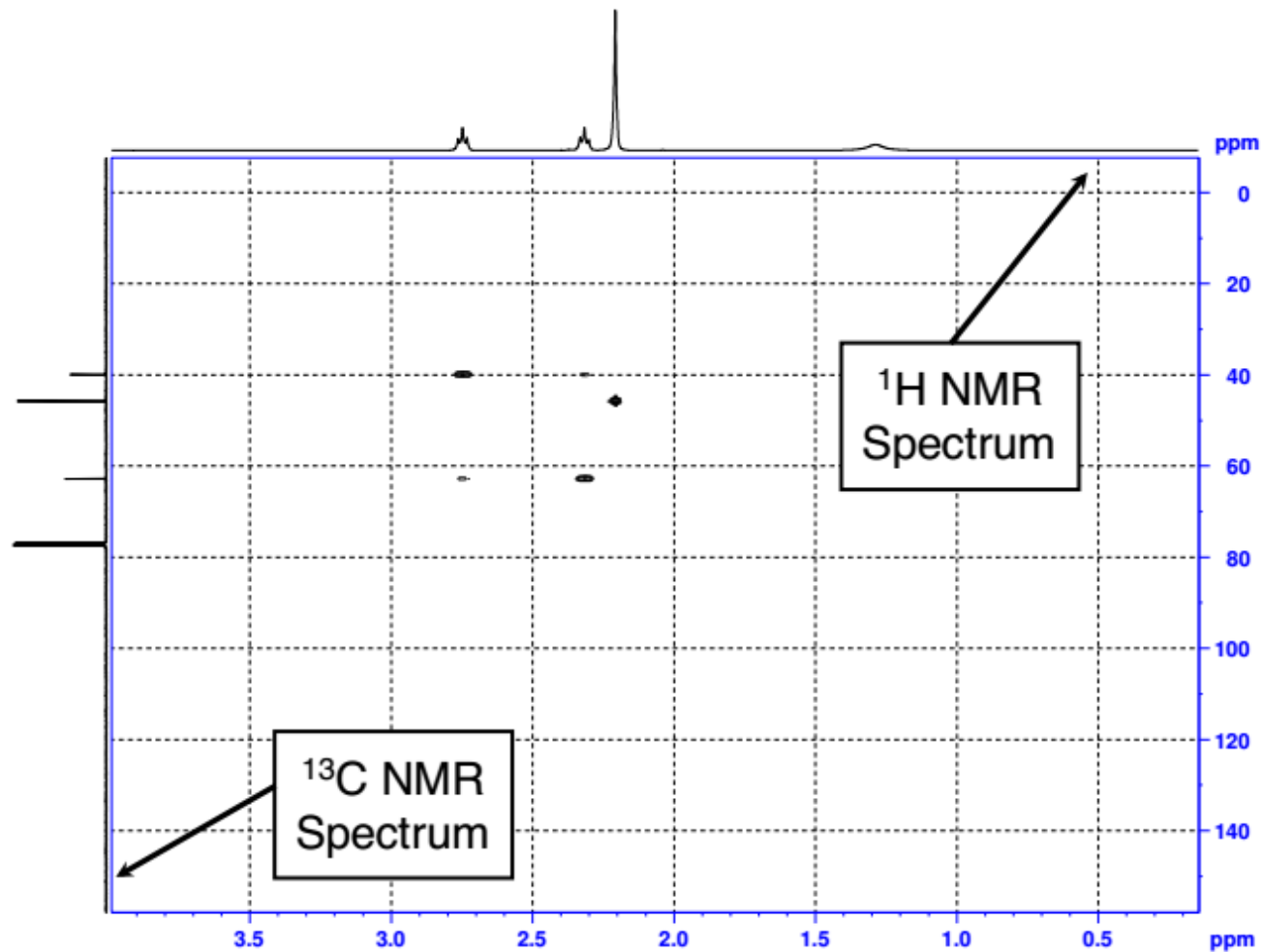
# COSY



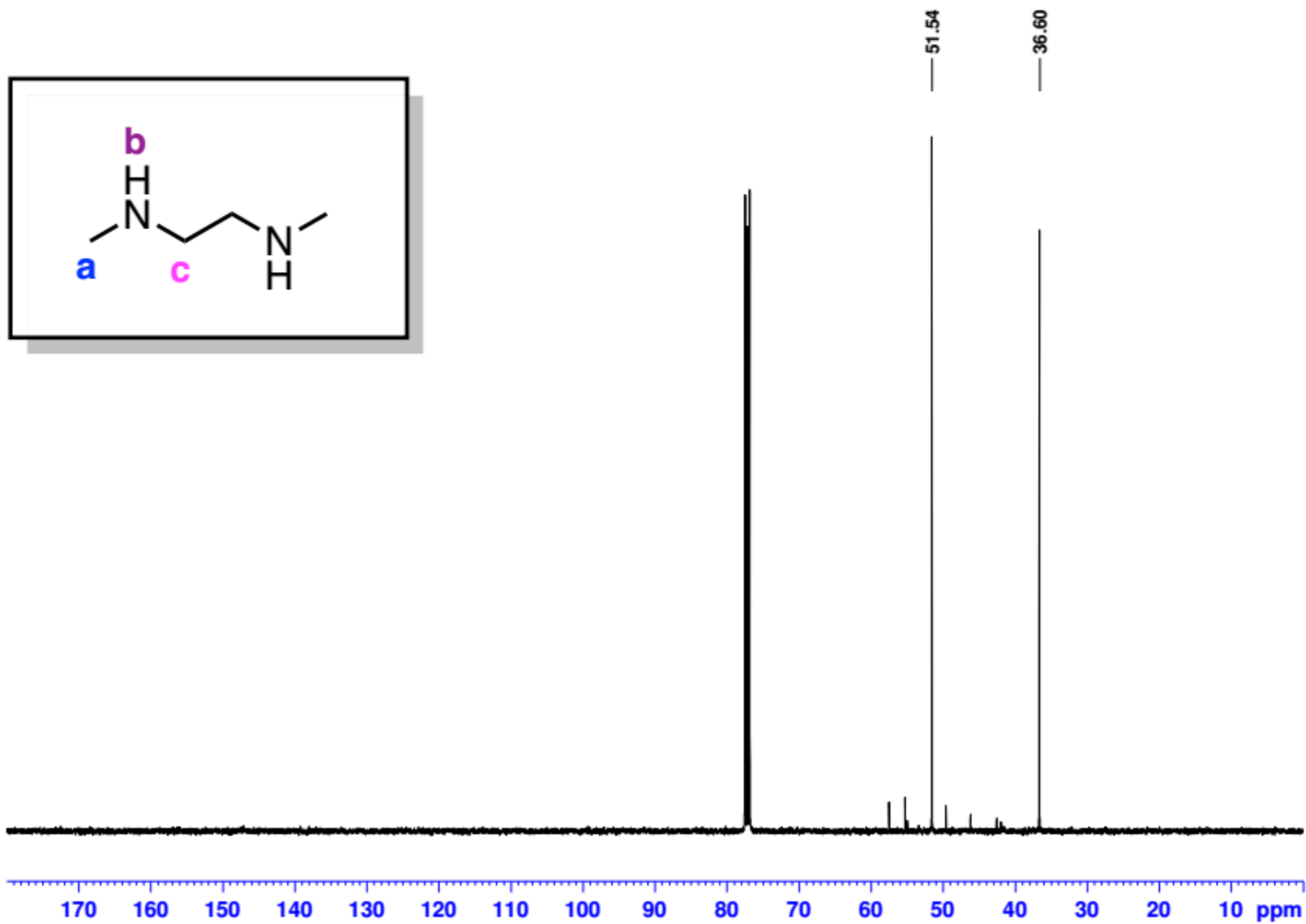
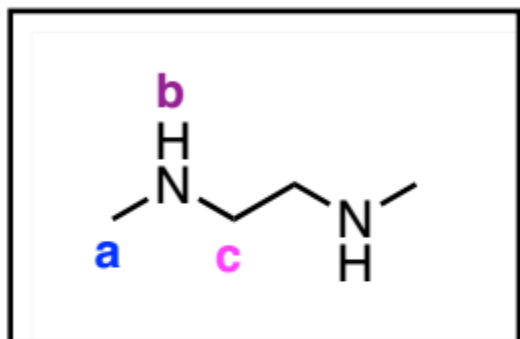


# Heteronuclear Single Quantum Coherence Spectroscopy (**HSQC**)

Shows correlations between carbons and protons that are bonded directly to one another.

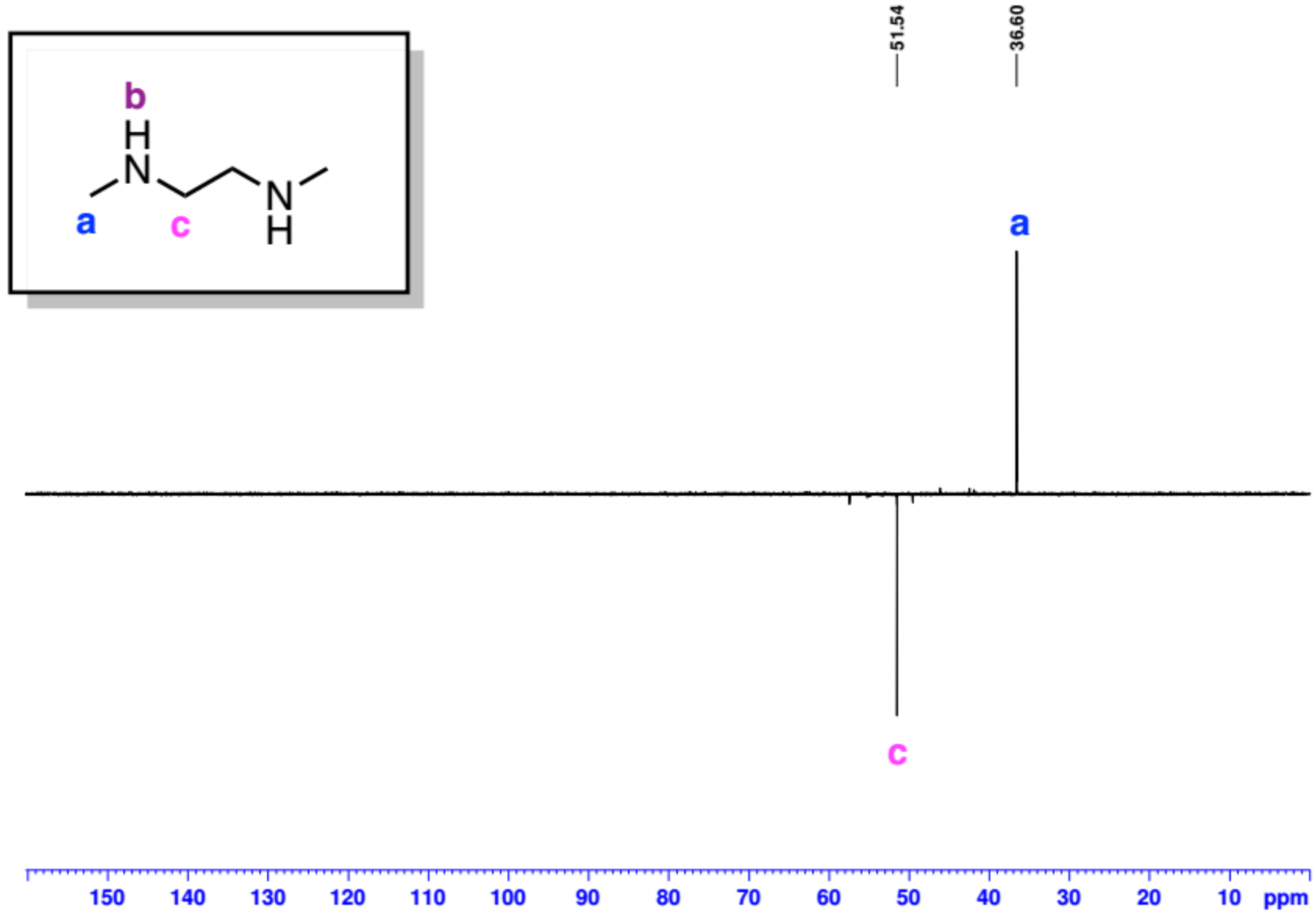


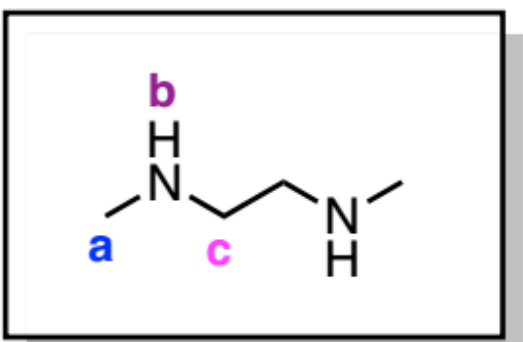
# $^{13}\text{C}$ NMR



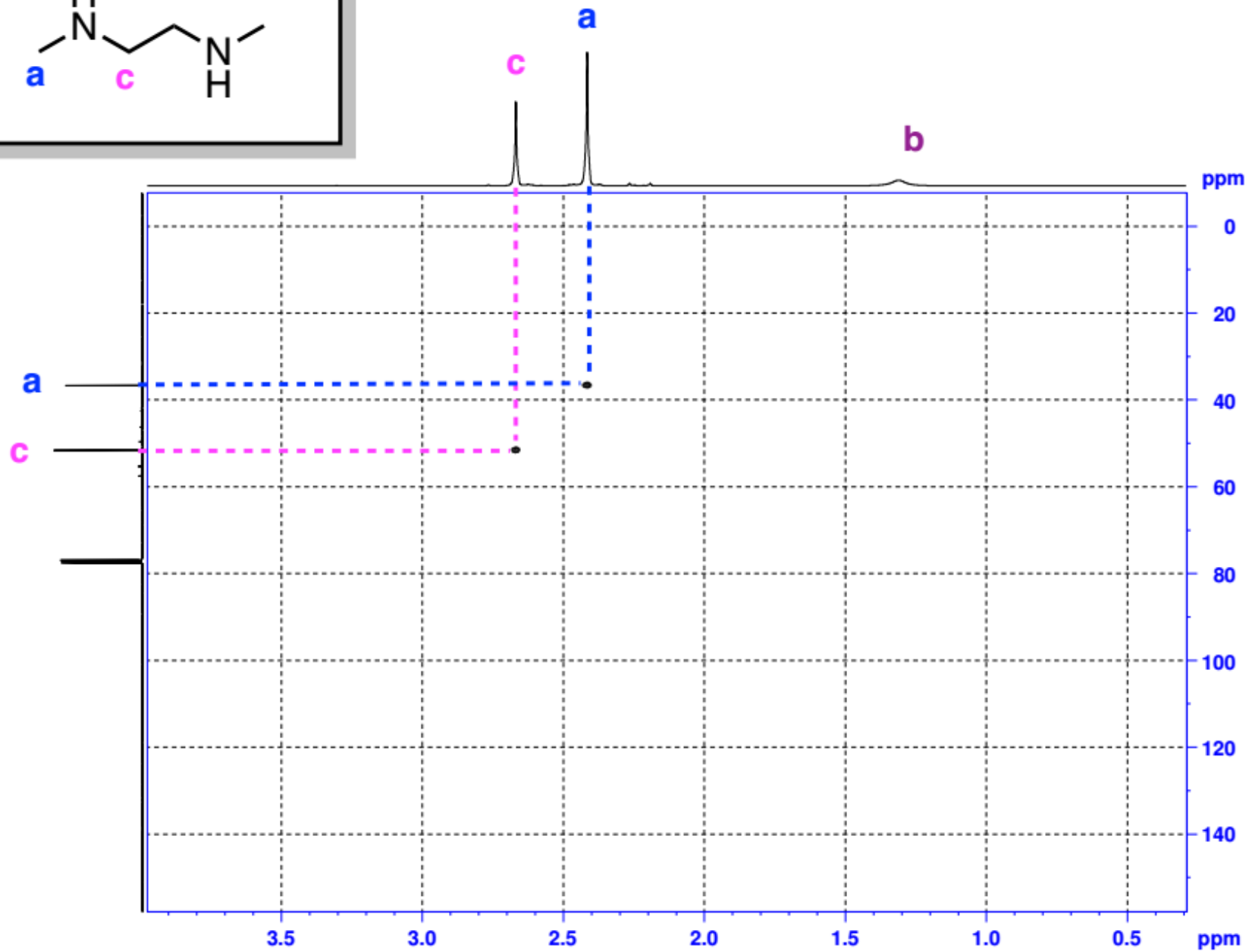
# DEPT - CH & CH<sub>3</sub> ↑, CH<sub>2</sub> ↓

Distortionless Enhancement by Polarization Transfer

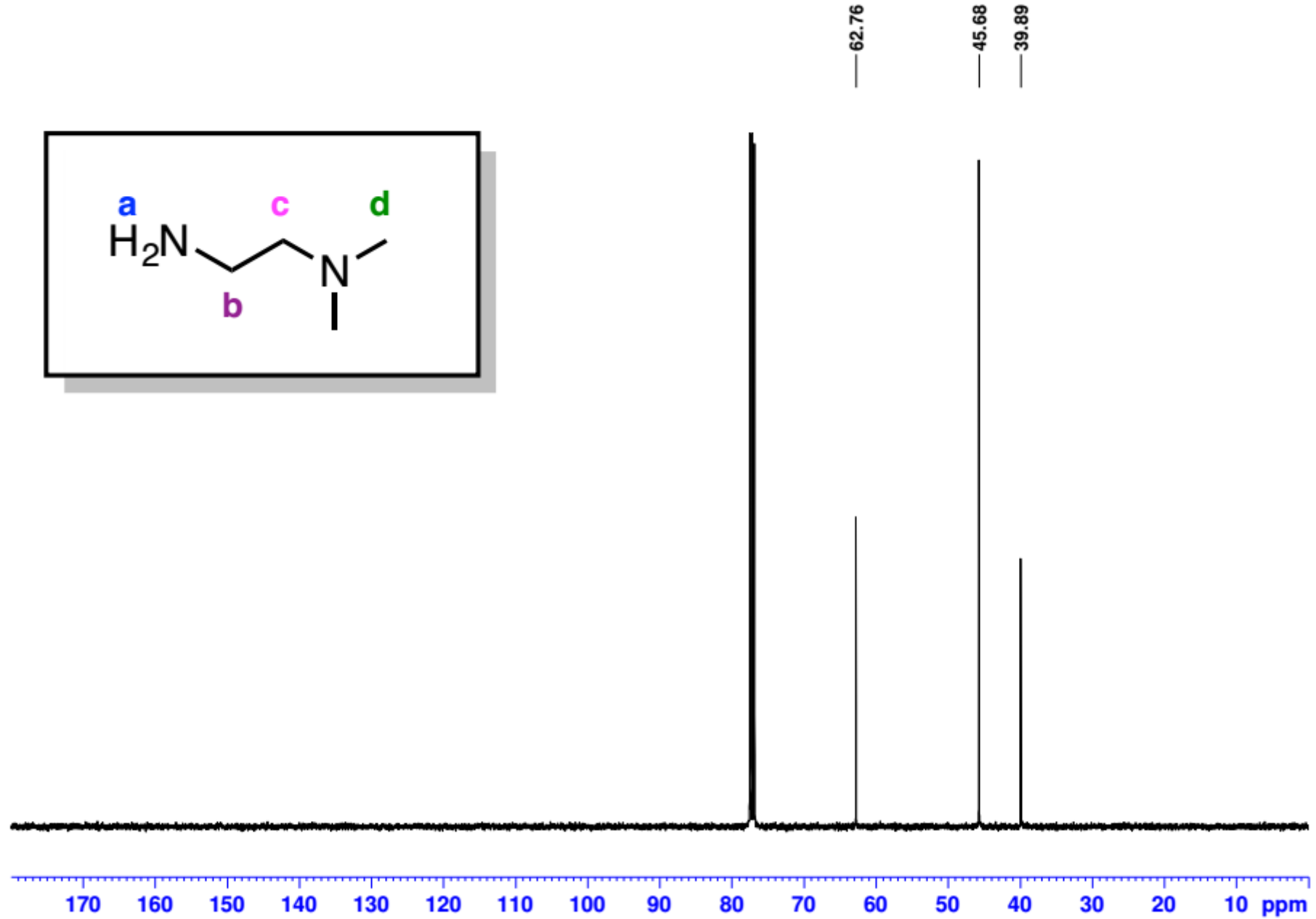
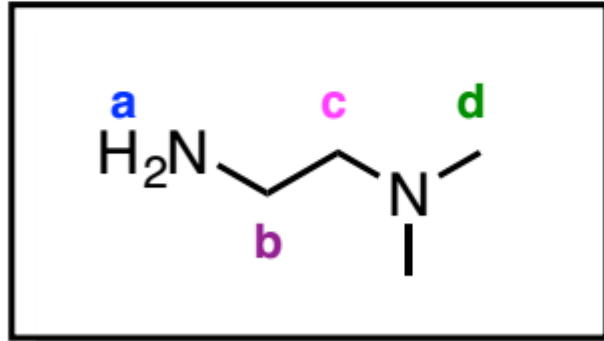




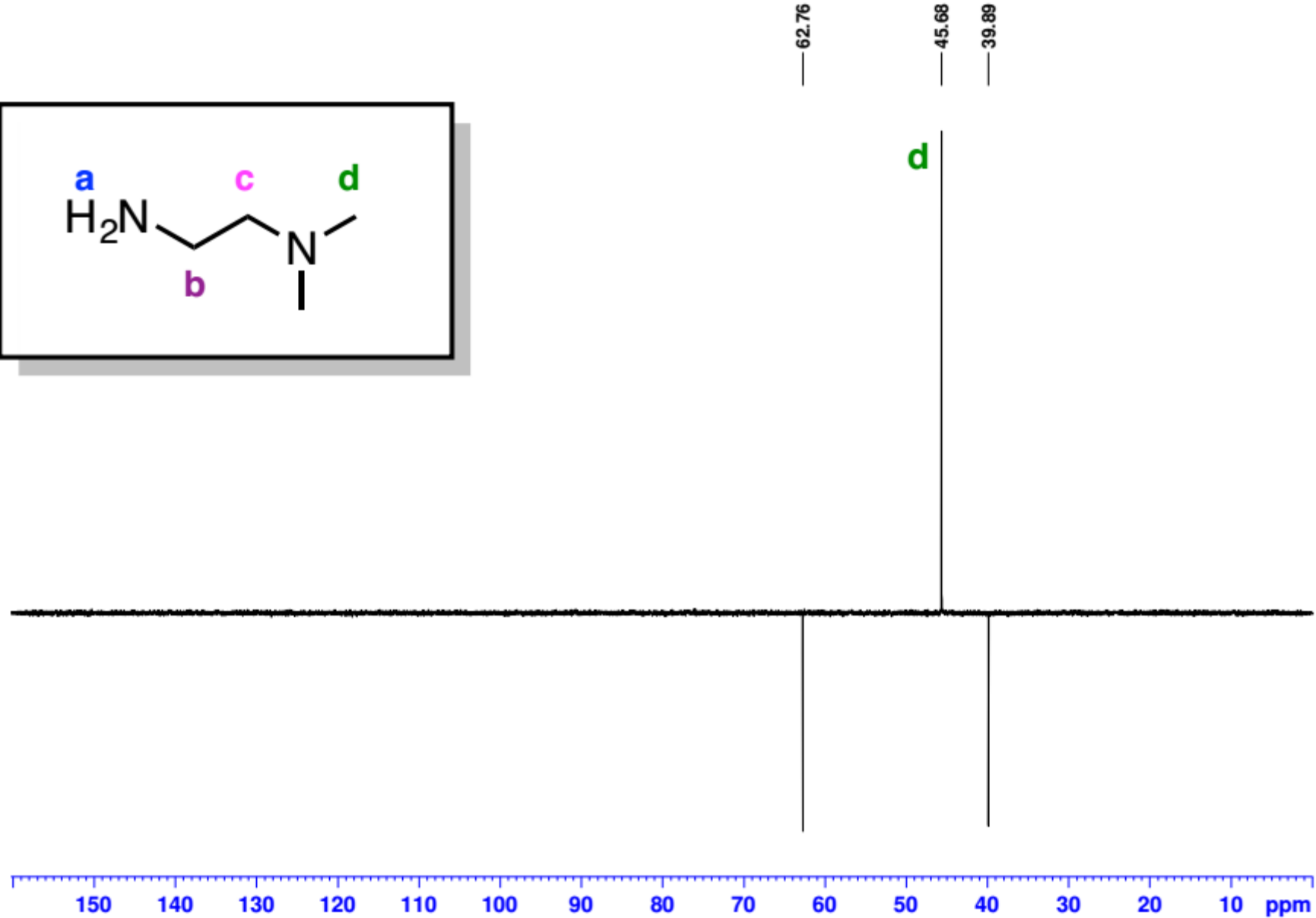
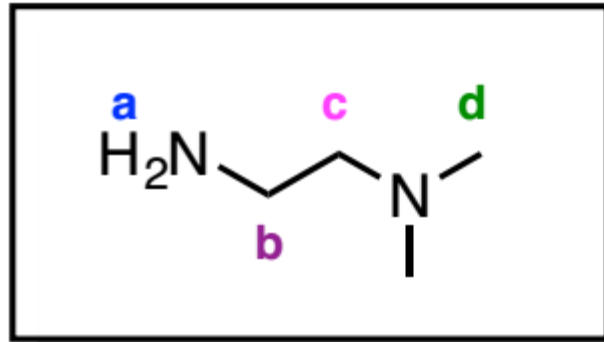
# HSQC

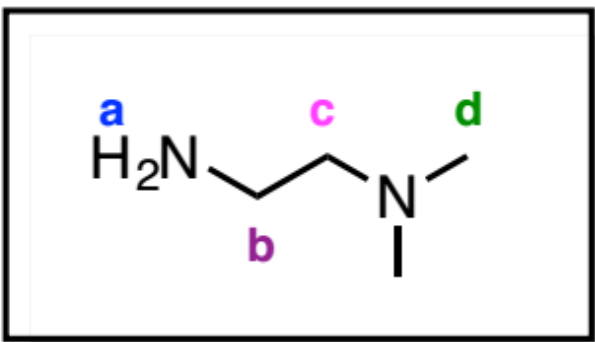


# $^{13}\text{C}$ NMR

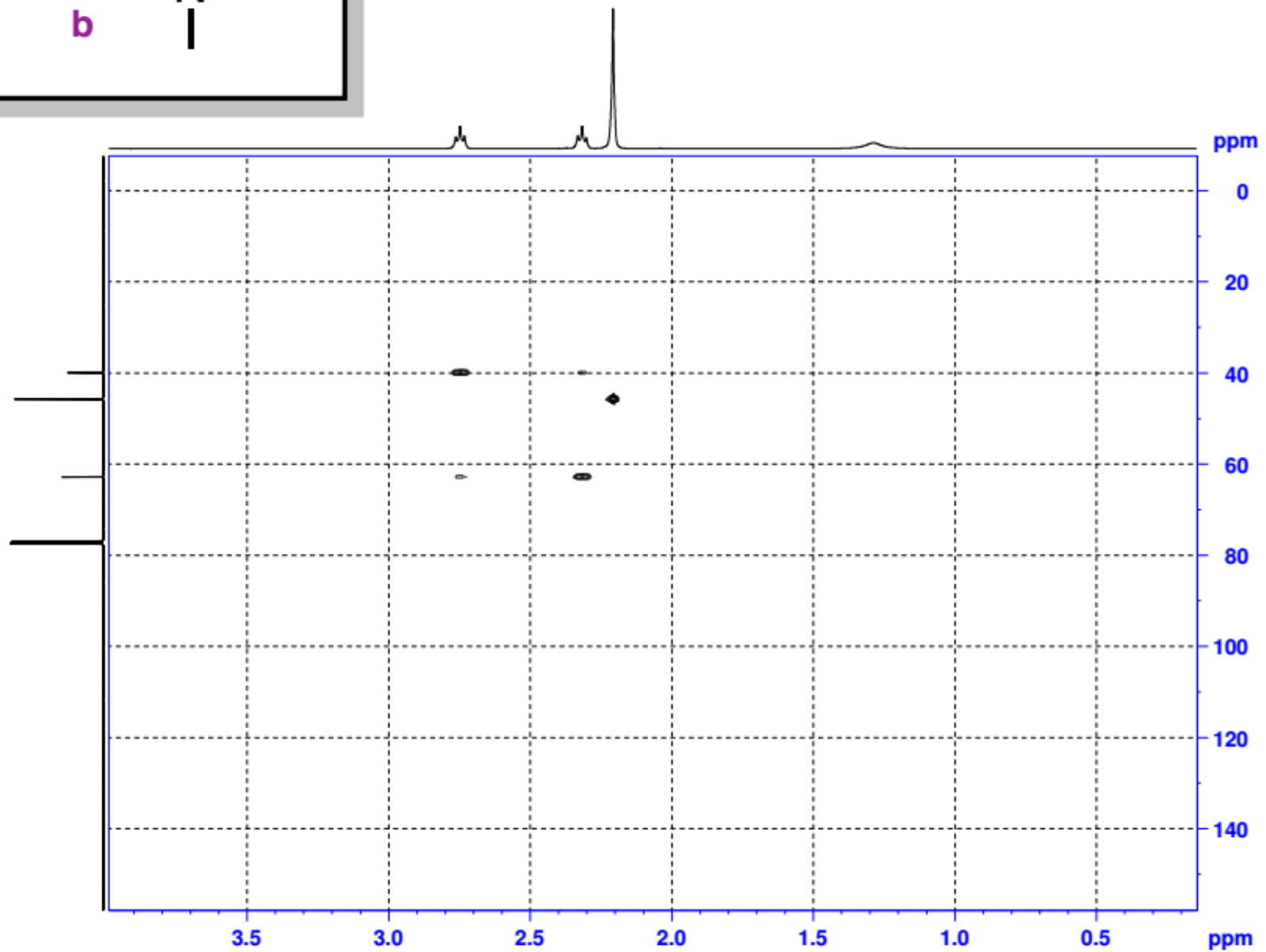


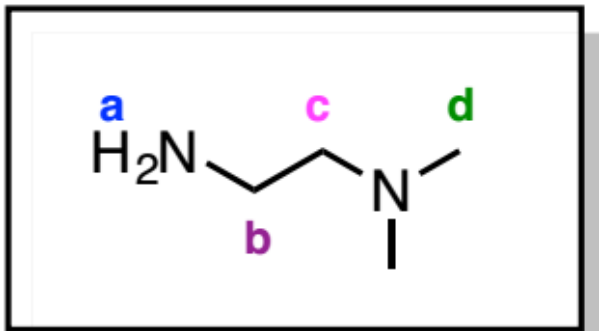
# DEPT - CH & CH<sub>3</sub> ↑, CH<sub>2</sub> ↓



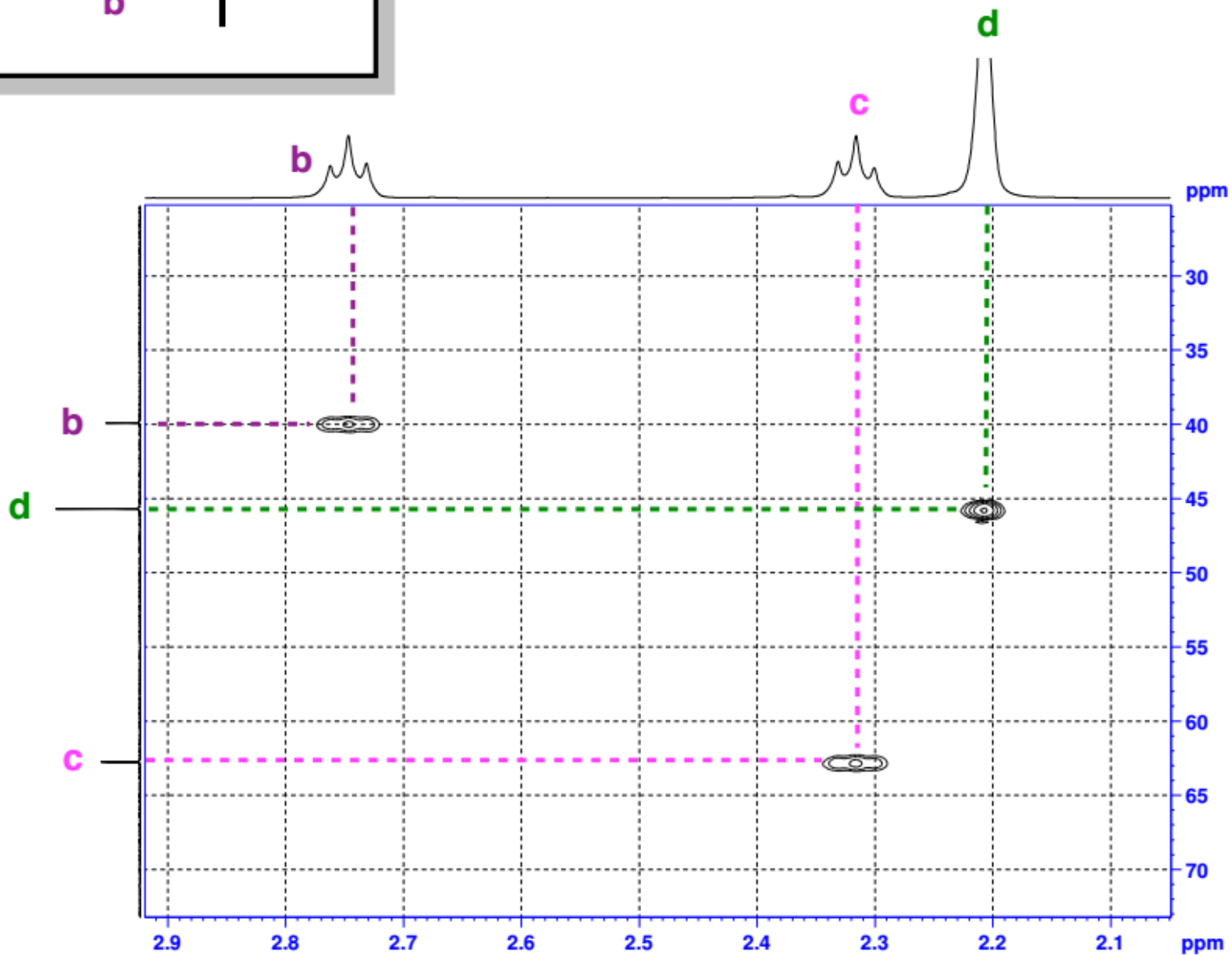


# HSQC



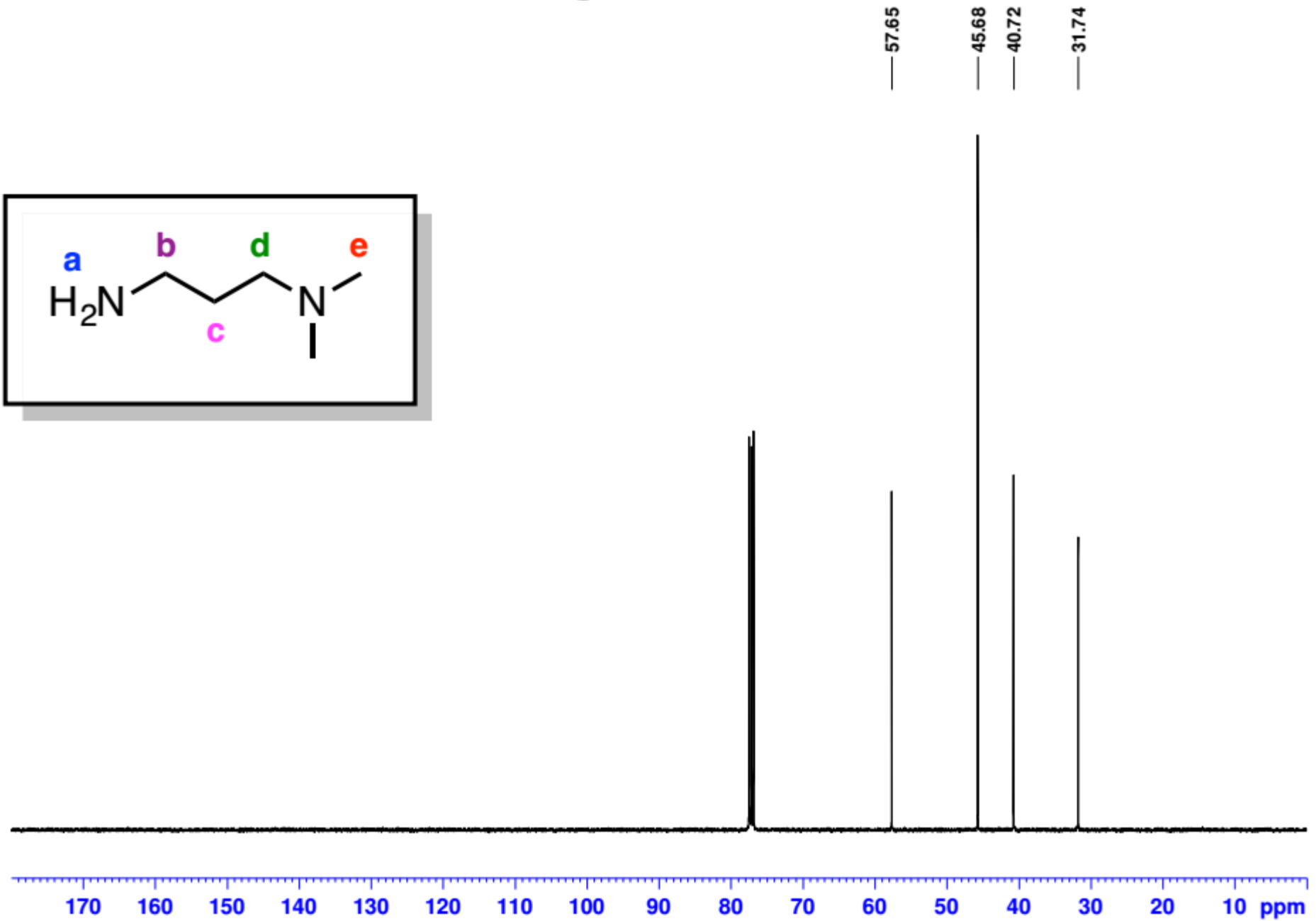
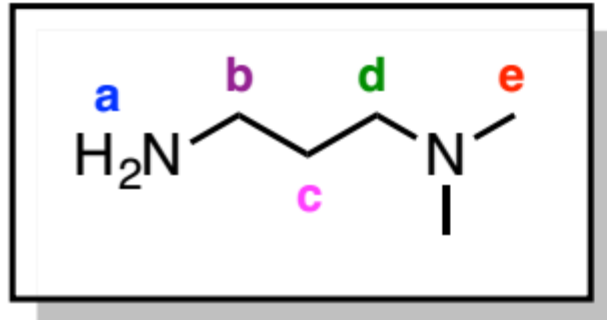


# HSQC

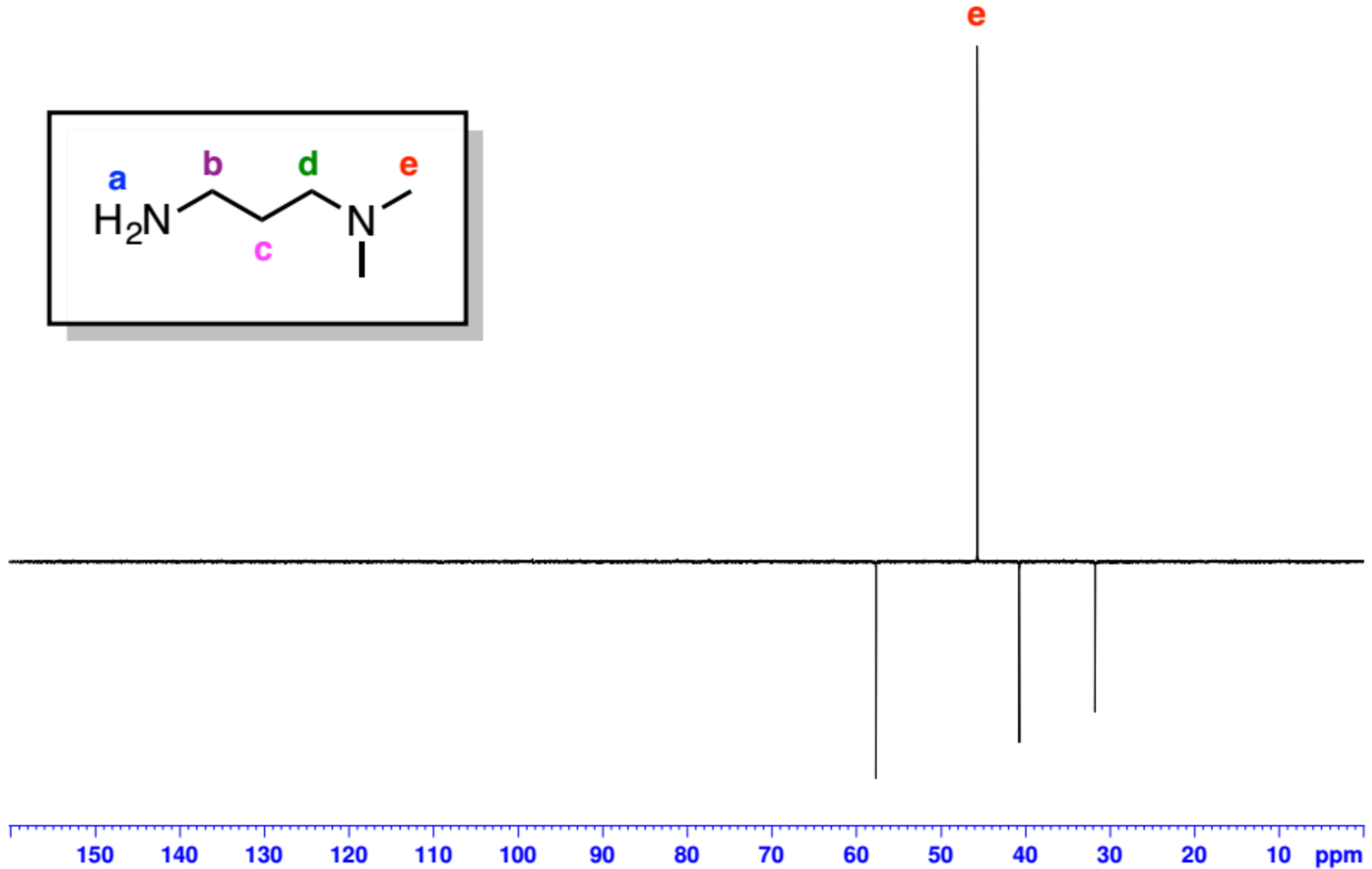
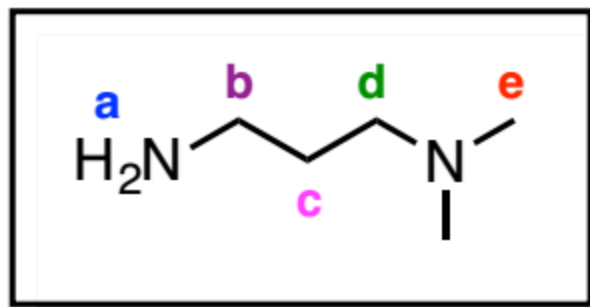




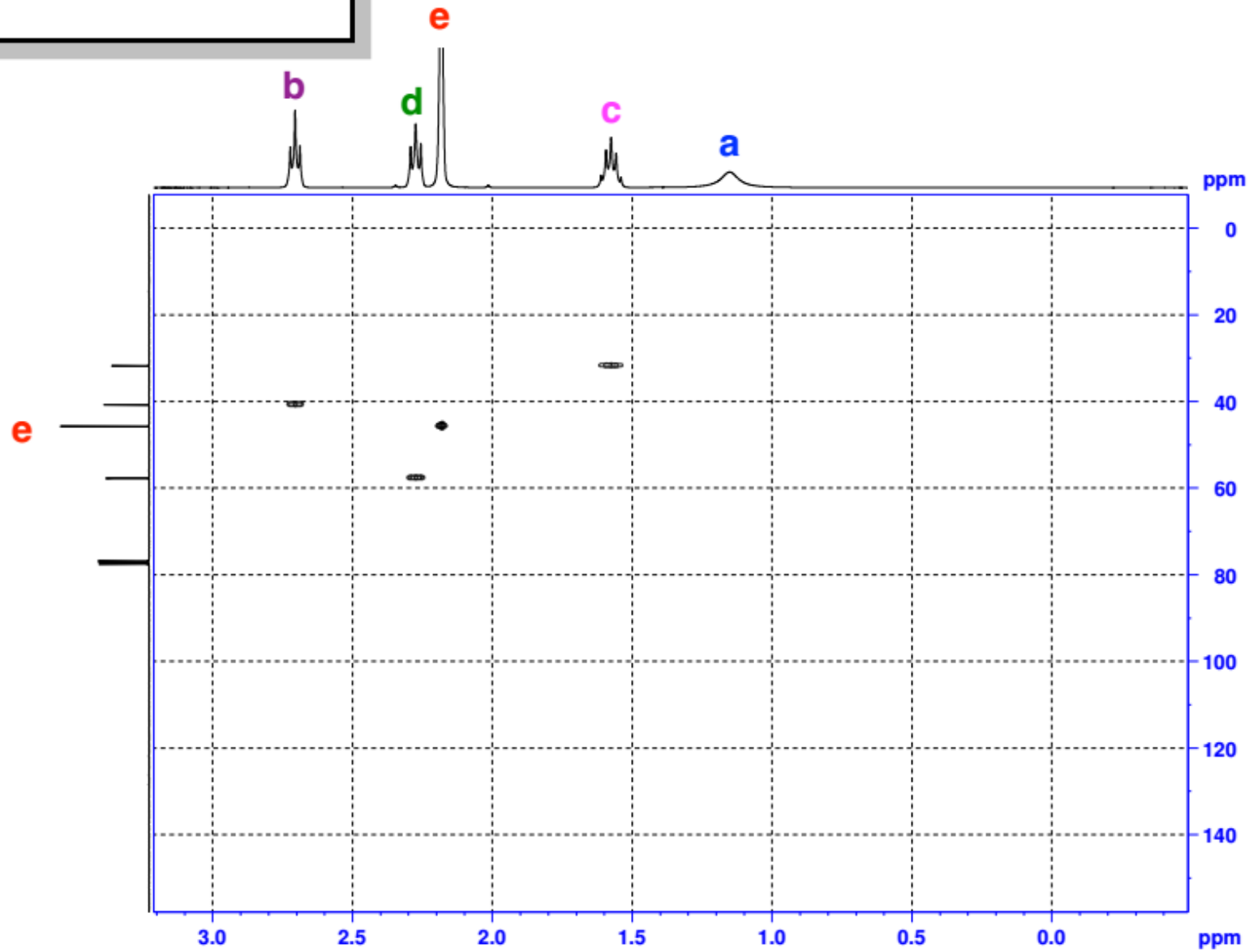
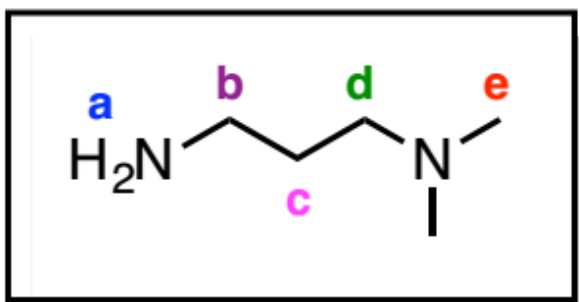
# $^{13}\text{C}$ NMR

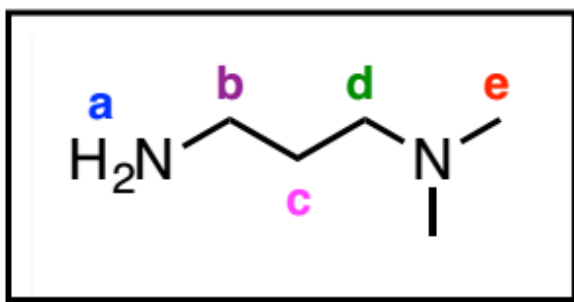


DEPT - CH & CH<sub>3</sub> ↑, CH<sub>2</sub> ↓

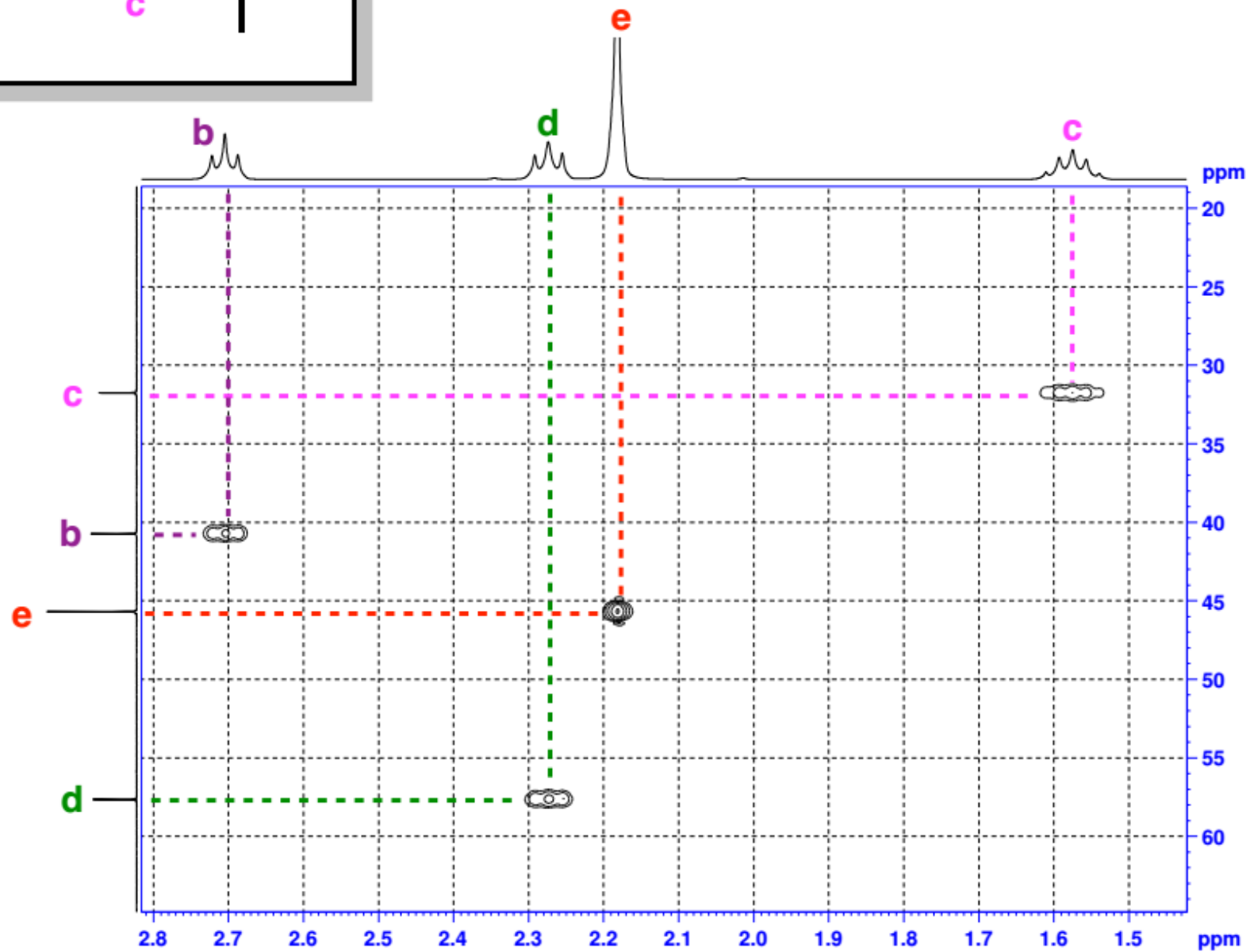


# HSQC



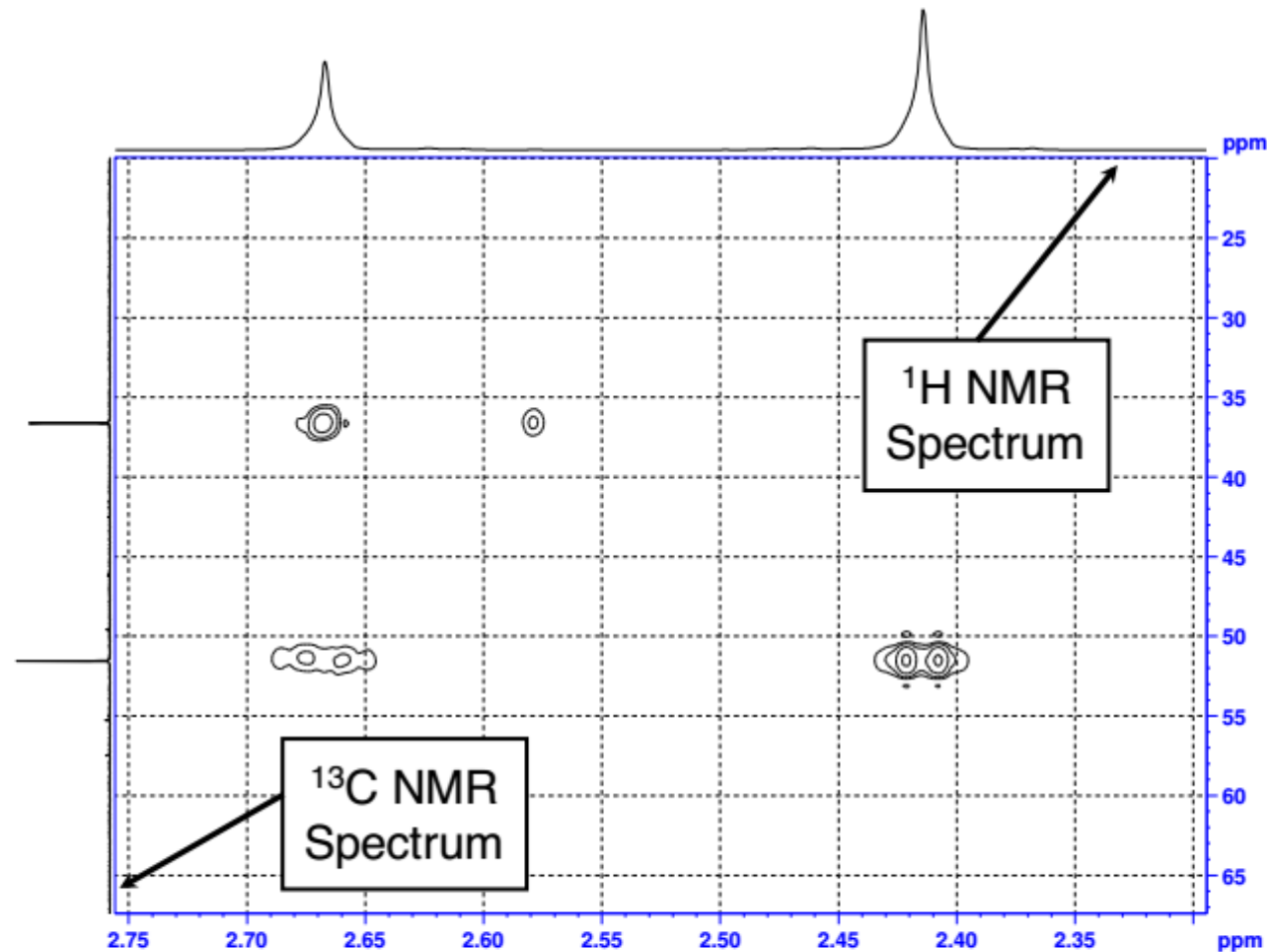


# HSQC

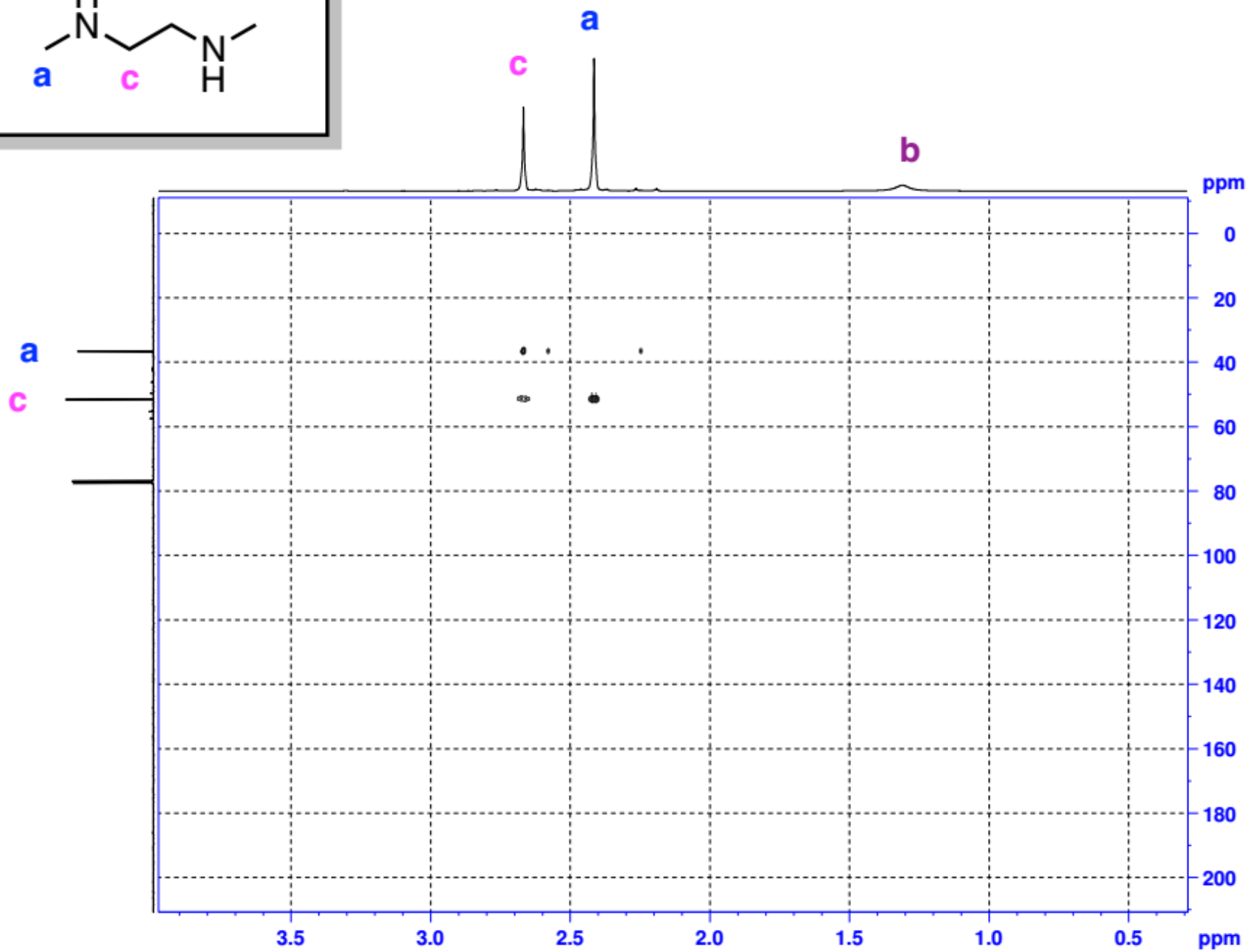
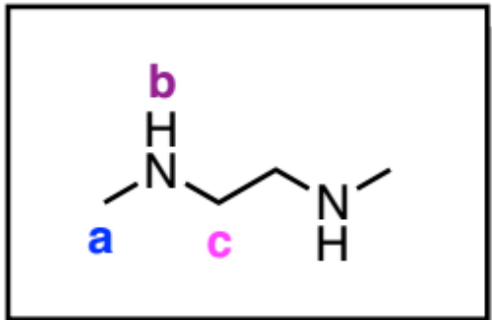


# Heteronuclear Multiple Bond Coherence Spectroscopy (HMBC)

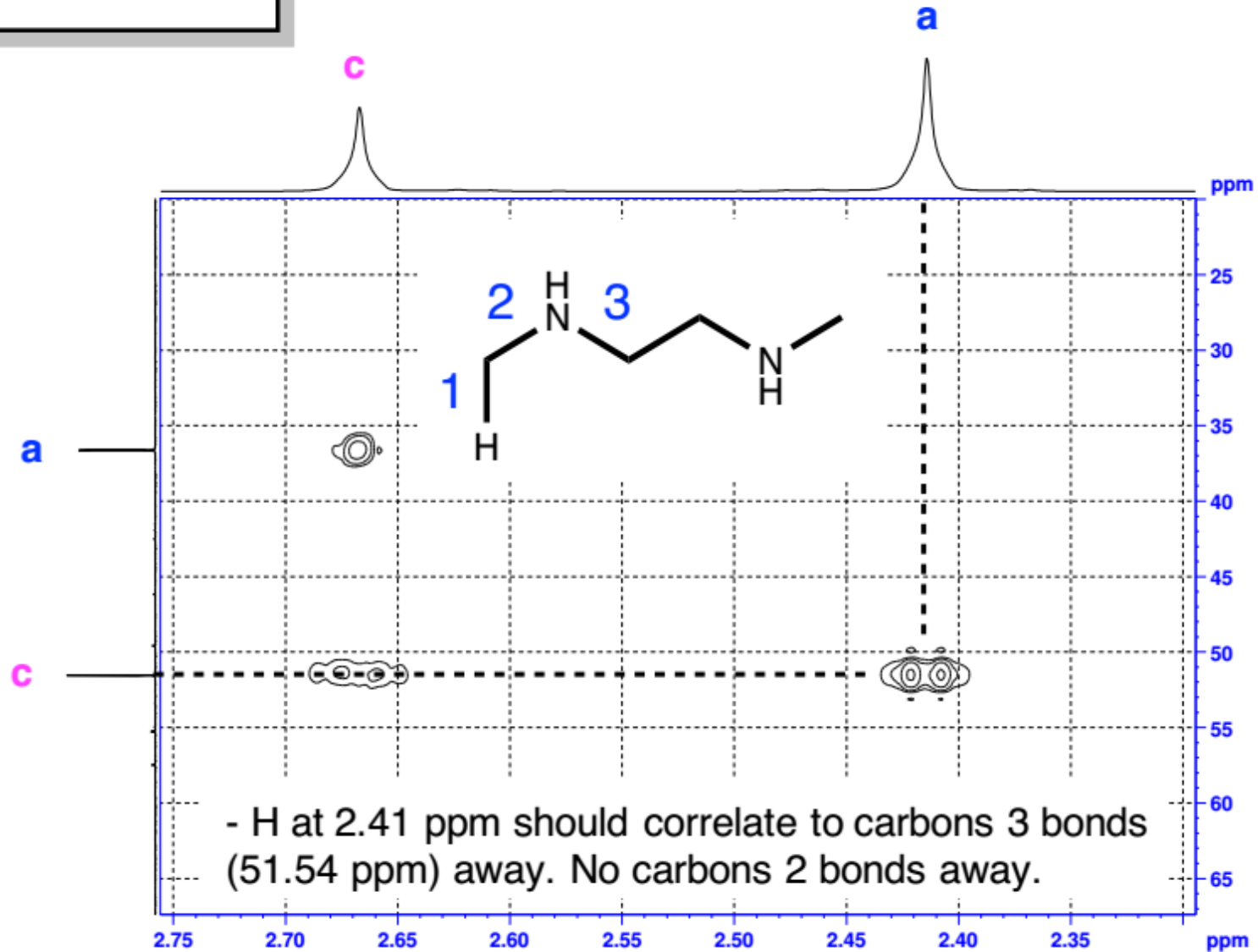
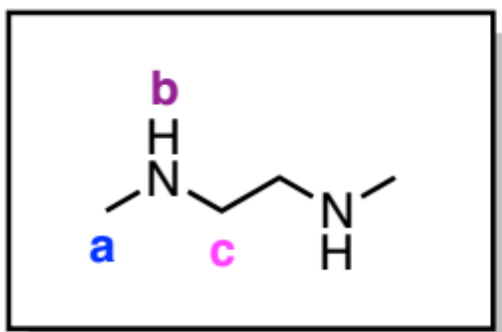
Shows correlations between protons and carbons that are two or three bonds apart.



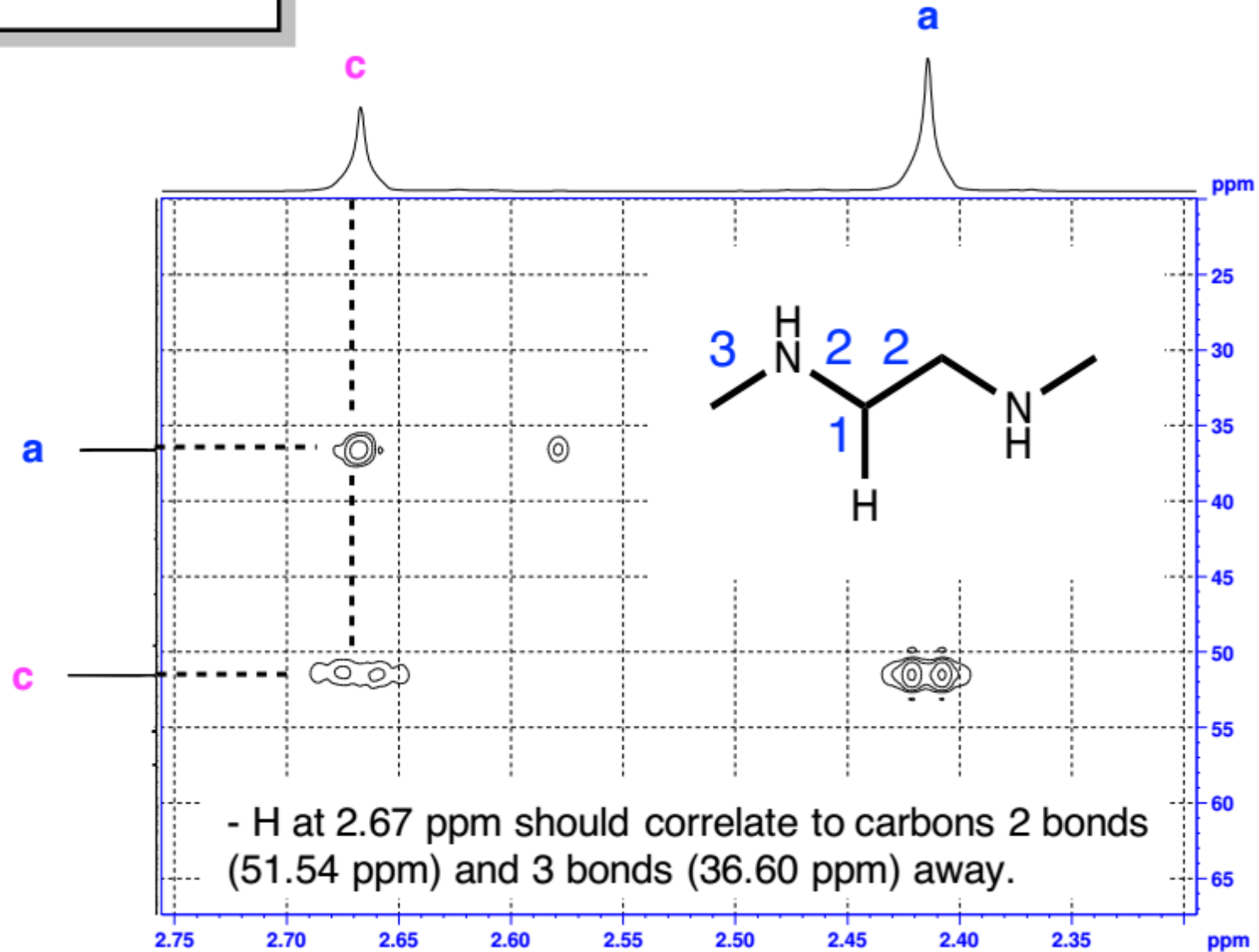
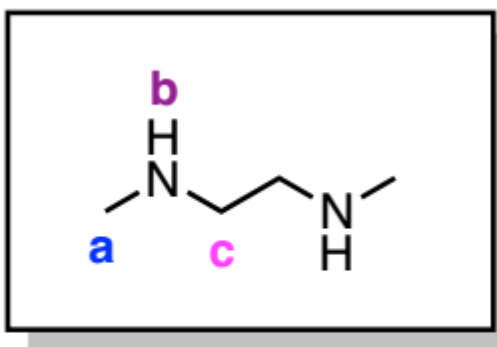
# HMBC



# HMBC

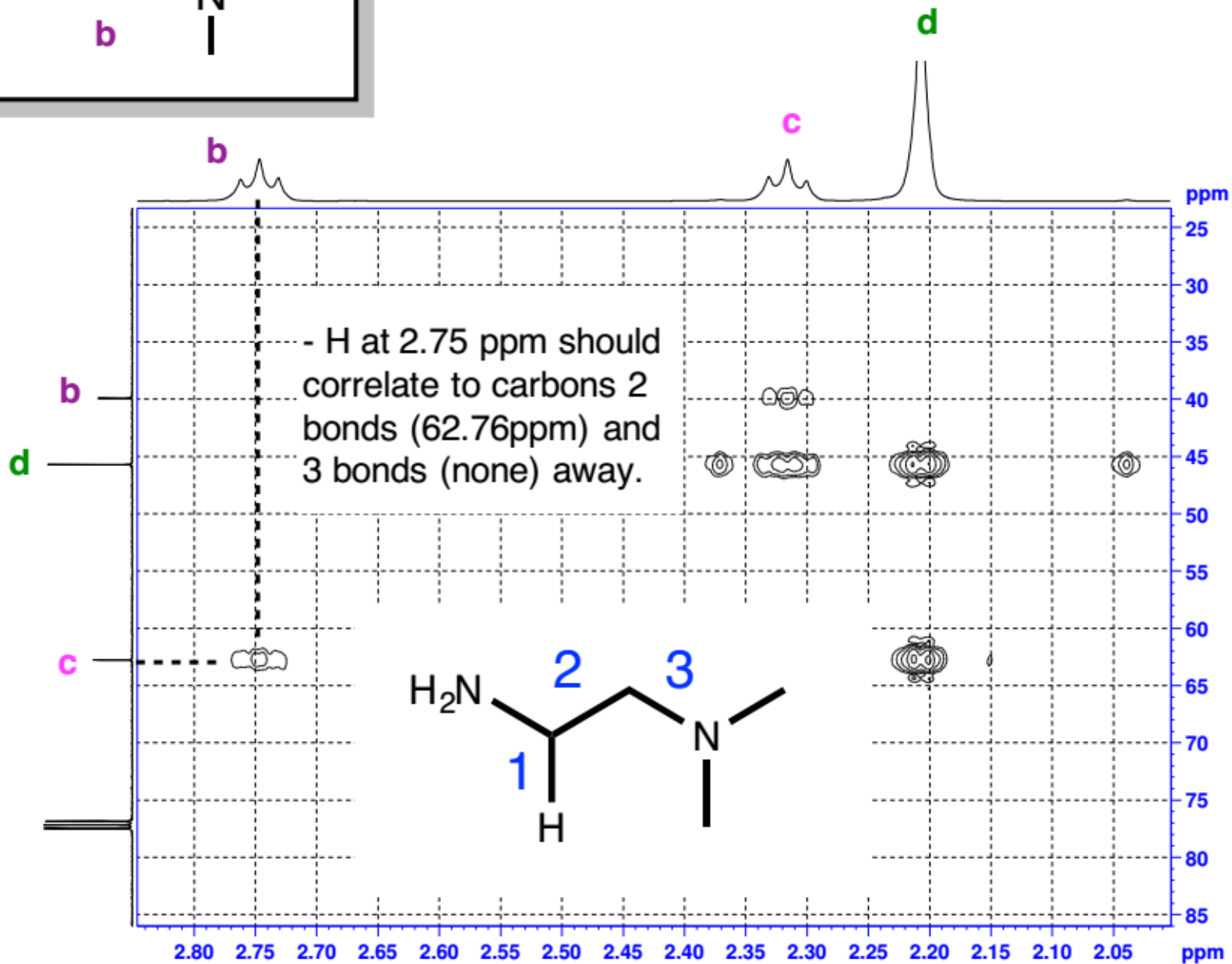
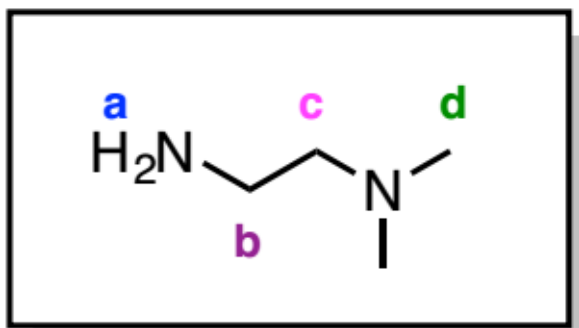


# HMBC

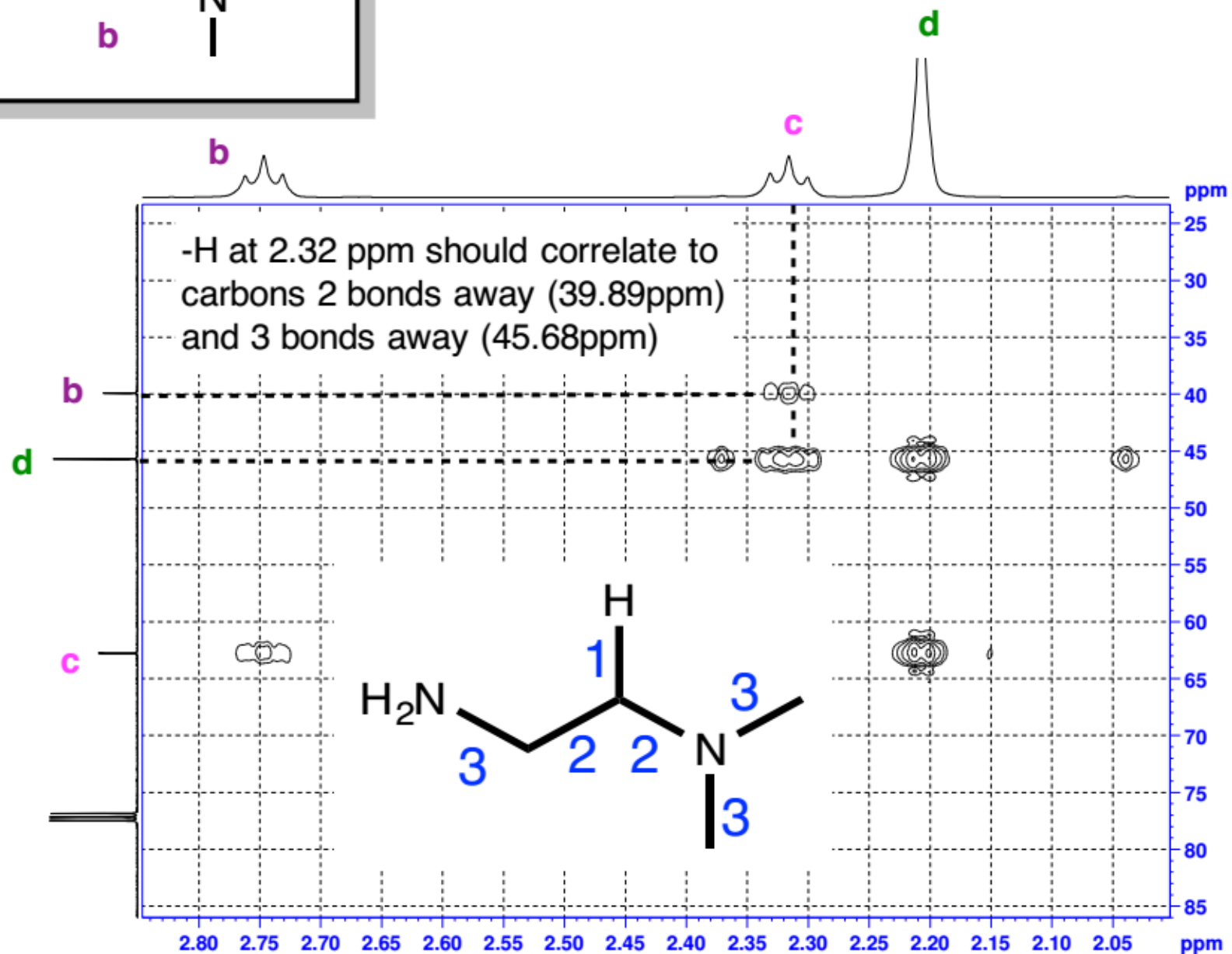
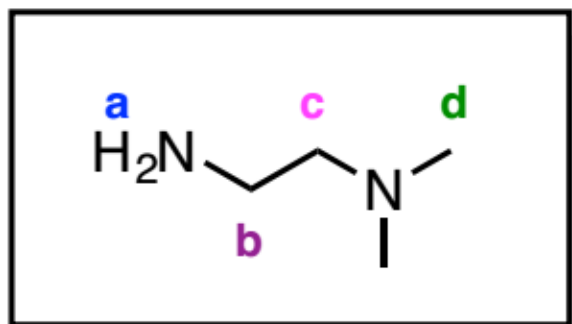




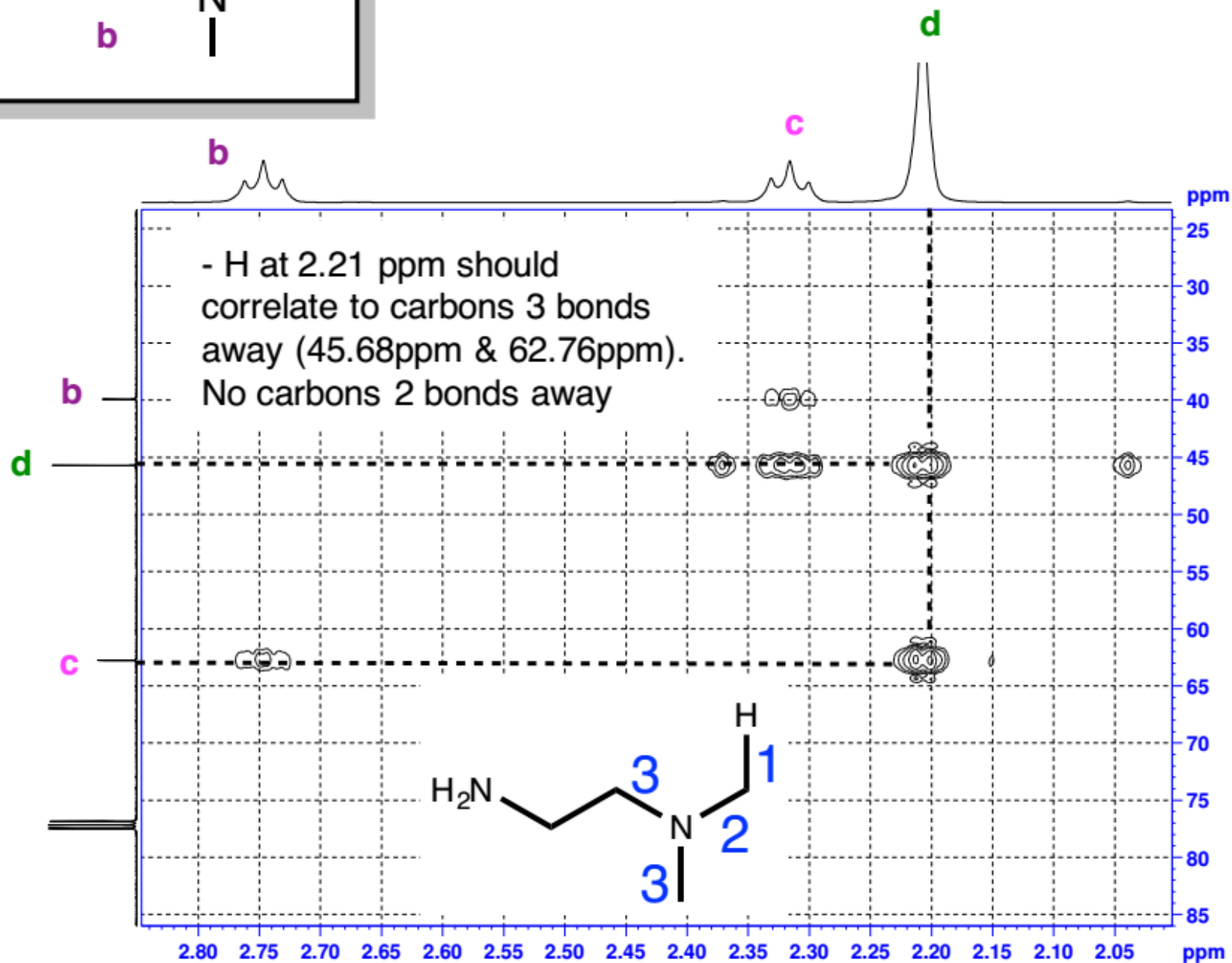
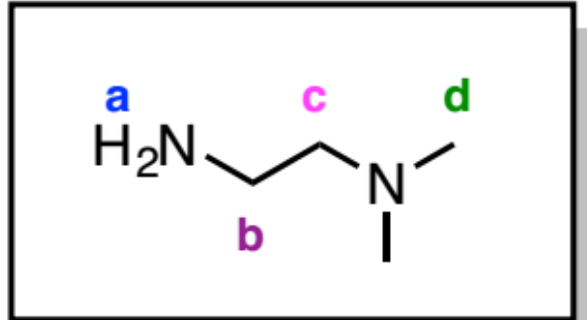
# HMBC

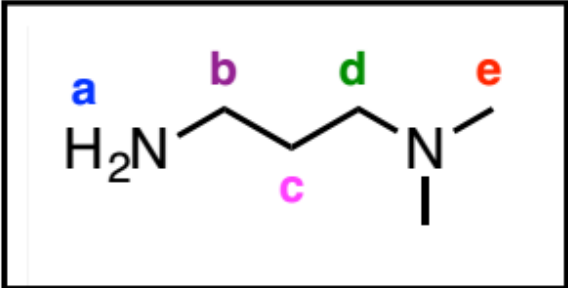


# HMBC

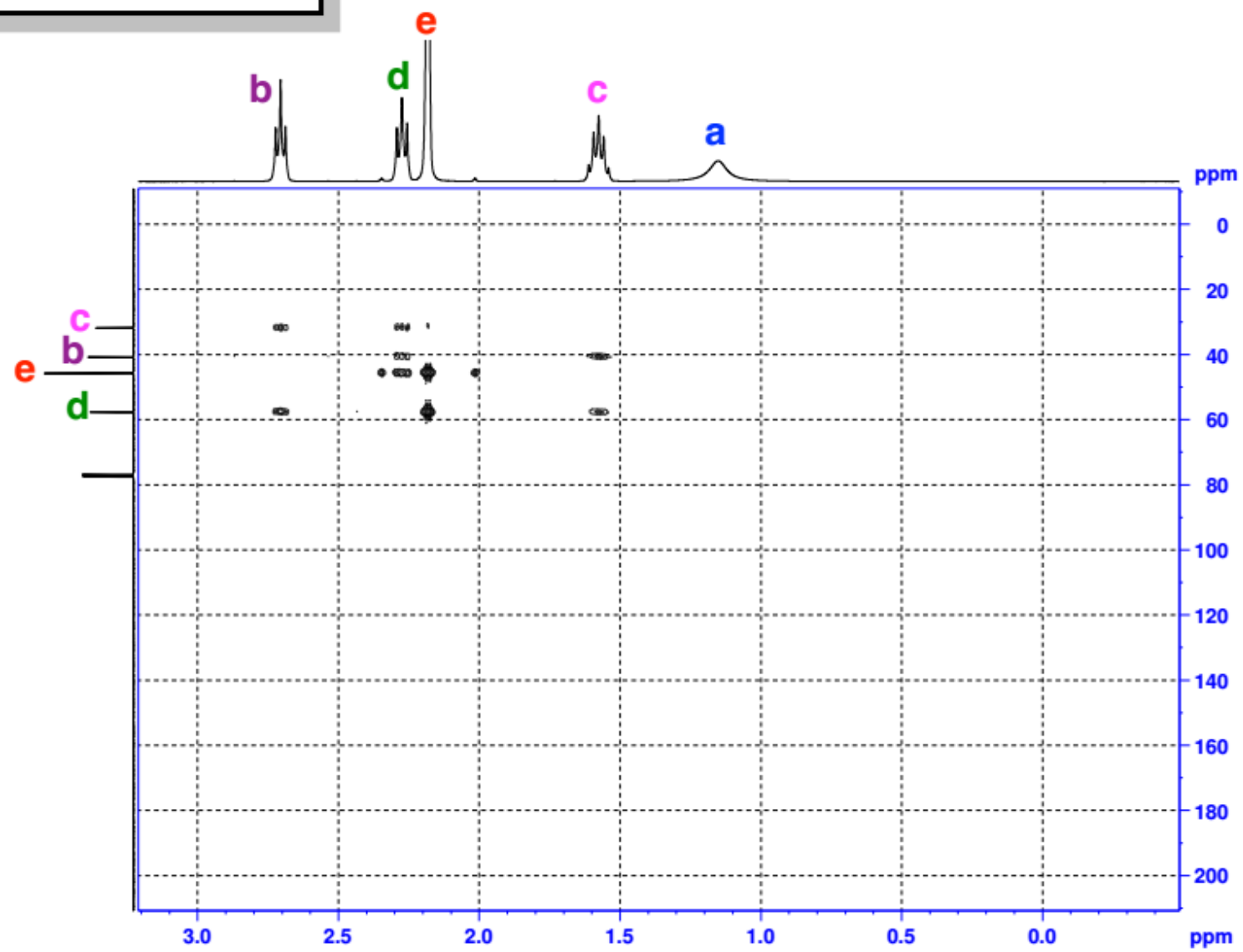


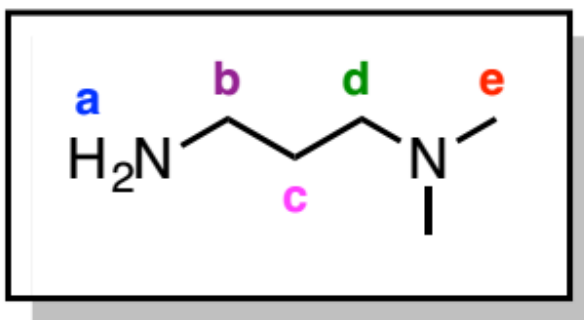
# HMBC



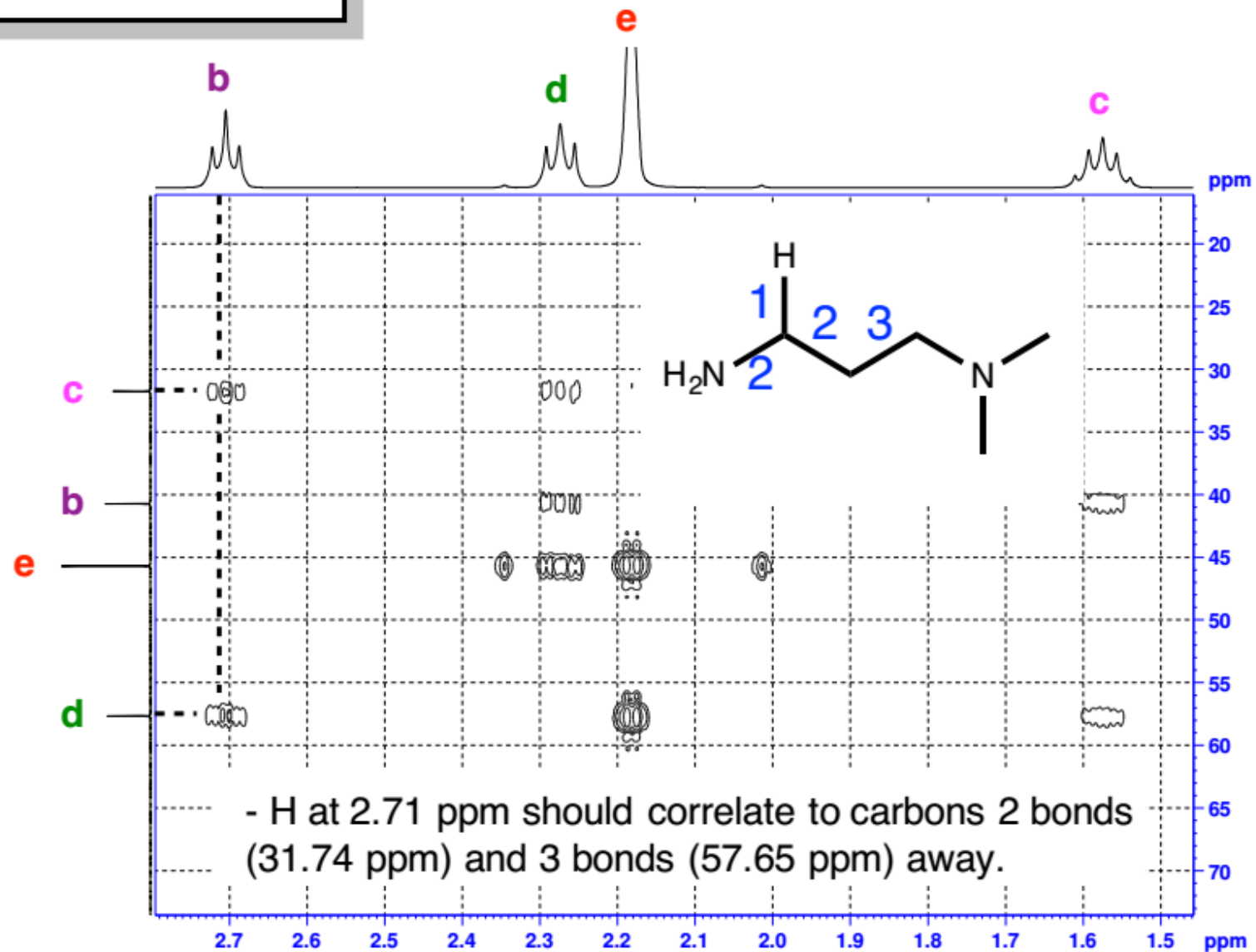


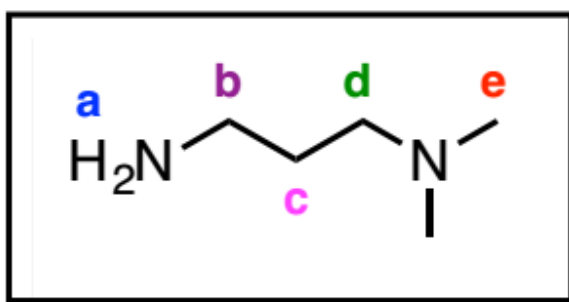
# HMBC



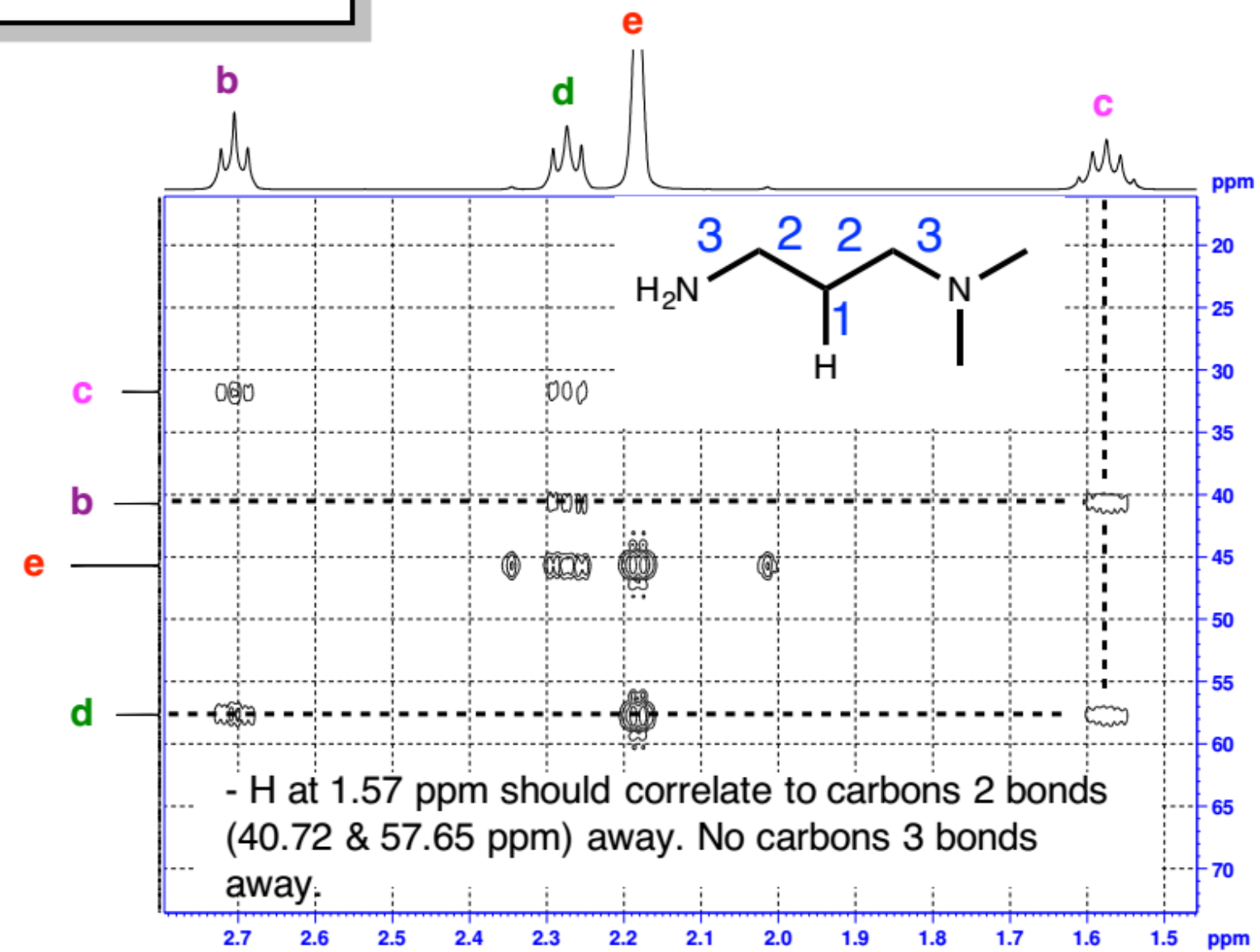


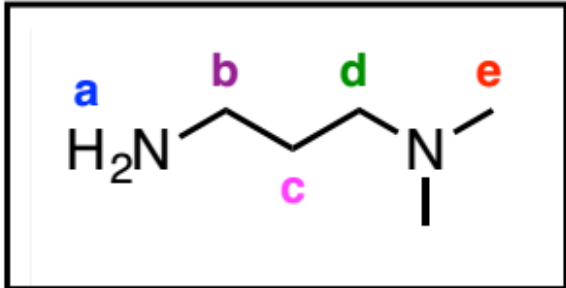
# HMBC



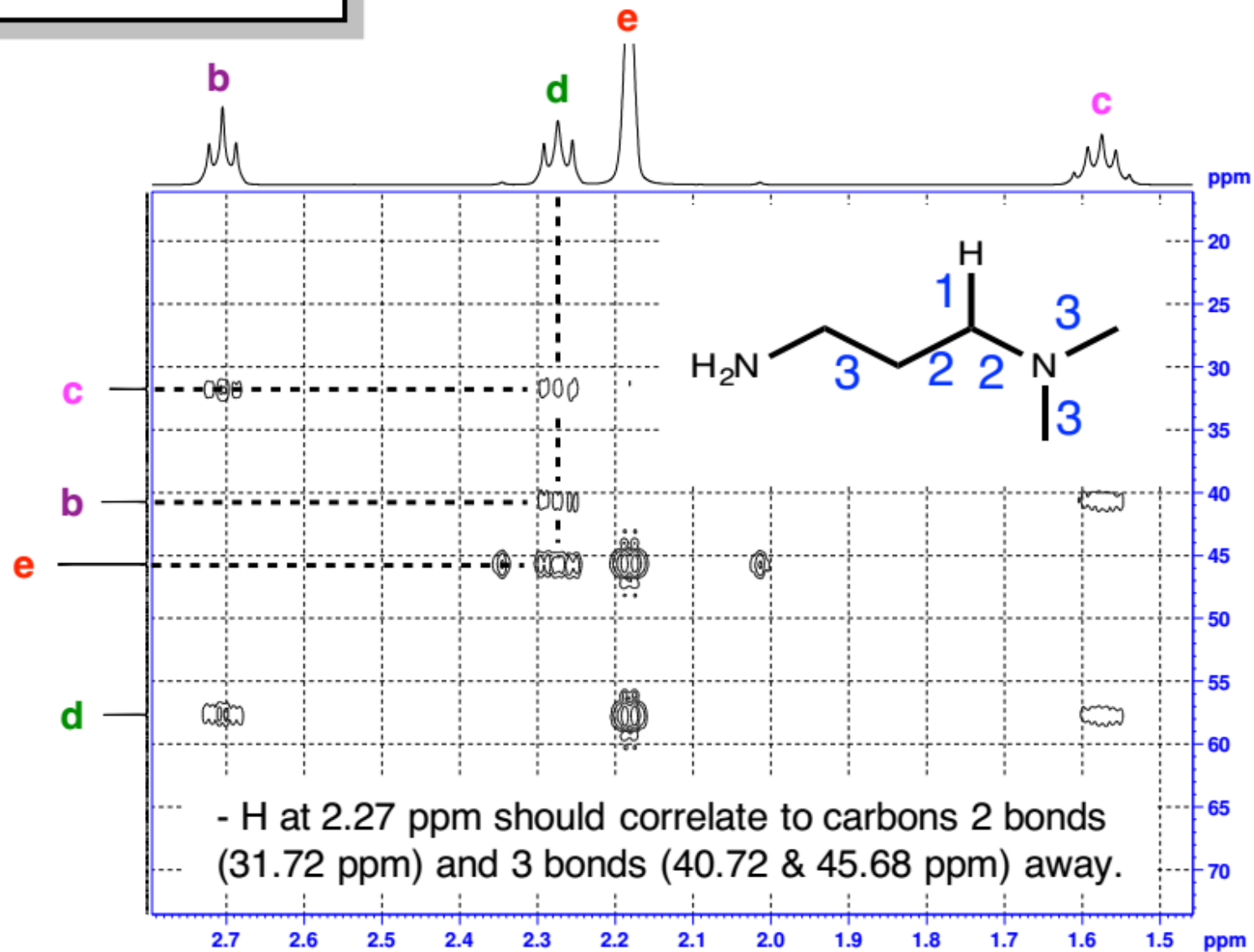


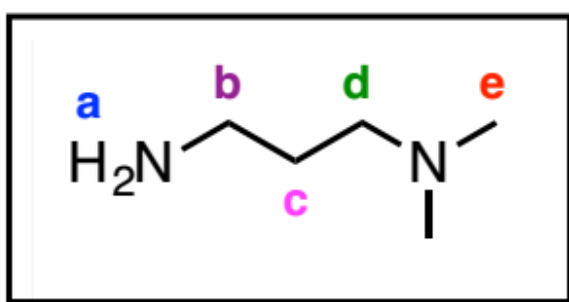
# HMBC





# HMBC





# HMBC

