Resulrts-analysis.r

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#Download librariers   
library(ggplot2)  
library(dplyr)

##   
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

library(viridis)

## Loading required package: viridisLite

library(tidyverse)

## ── Attaching packages ───────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────── tidyverse 1.3.0 ──

## ✓ tibble 3.0.3 ✓ purrr 0.3.4  
## ✓ tidyr 1.1.0 ✓ stringr 1.4.0  
## ✓ readr 1.3.1 ✓ forcats 0.5.0

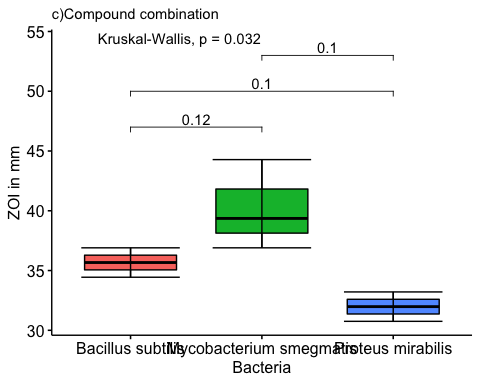
## ── Conflicts ──────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────────── tidyverse\_conflicts() ──  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

library(ggpubr)  
library(ggrepel)  
library(ggsci)  
library(ggsignif)  
library(ggthemes)  
#DISK DIFUSSION TESTS ANALYSIS   
# make a variable that contains all bacterial names and print it out.   
Titles <- c("Bacillus subtilis","Mycobacterium smegmatis","Proteus mirabilis")  
#Order the titels   
Titles\_test <- c(rep("Bacillus subtilis",3),rep("Mycobacterium smegmatis",3),rep("Proteus mirabilis",3))  
#Treatment names   
Treatment\_names <- c("Compound combination", "penicillin only", "Tebipenem only")  
#Create variables that contain ZOIs measurements according to the bacteria and the treatment   
Bacillus\_subtilis\_Combination <- c(36.9, 34.44, 35.67)  
Bacillus\_subtilis\_Tebipenem <-c(34.44,29.52,35.67)  
Bacillus\_subtilis\_Penicilin <- c(0,0,0)  
Mycobacterium\_smegmatis\_Combination <- c(39.36,36.9,44.28)  
Mycobacterium\_smegmatis\_Tebipenem <- c(39.36,34.44,41.82)  
Mycobacterium\_smegmatis\_Penicilin <- c(0,0,0)  
Proteus\_mirabilis\_Combination <- c(30.75,31.98,33.21)  
Proteus\_mirabilis\_Tebipenem <- c(33.21,31.98,34.44)  
Proteus\_mirabilis\_Penicillin <- c(27.06,29.52,31.98)  
#Create a data frame of pLates results(this will make a table of the results) and print it out  
results <- data.frame(Bacteria=Titles\_test,  
 Compound\_combination= c(Bacillus\_subtilis\_Combination,  
 Mycobacterium\_smegmatis\_Combination,  
 Proteus\_mirabilis\_Combination),  
 Tebipenem\_only= c(Bacillus\_subtilis\_Tebipenem,  
 Mycobacterium\_smegmatis\_Tebipenem,  
 Proteus\_mirabilis\_Tebipenem),  
 Penicillin\_only= c(Bacillus\_subtilis\_Penicilin,  
 Mycobacterium\_smegmatis\_Penicilin,  
 Proteus\_mirabilis\_Penicillin))  
print(results)

## Bacteria Compound\_combination Tebipenem\_only Penicillin\_only  
## 1 Bacillus subtilis 36.90 34.44 0.00  
## 2 Bacillus subtilis 34.44 29.52 0.00  
## 3 Bacillus subtilis 35.67 35.67 0.00  
## 4 Mycobacterium smegmatis 39.36 39.36 0.00  
## 5 Mycobacterium smegmatis 36.90 34.44 0.00  
## 6 Mycobacterium smegmatis 44.28 41.82 0.00  
## 7 Proteus mirabilis 30.75 33.21 27.06  
## 8 Proteus mirabilis 31.98 31.98 29.52  
## 9 Proteus mirabilis 33.21 34.44 31.98

#make up the variable that constructs the boxplot for Compound combination effect on three bacteria  
my\_comparisons <- list(c("Bacillus subtilis","Mycobacterium smegmatis"),  
 c("Bacillus subtilis","Proteus mirabilis"),  
 c("Mycobacterium smegmatis","Proteus mirabilis"))  
combin<-ggboxplot(results,x="Bacteria",y="Compound\_combination",fill = "Bacteria")+  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 ) +  
 ggtitle("c)Compound combination") +  
 xlab("Bacteria")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 stat\_compare\_means(comparisons = my\_comparisons,  
 label.y = c(47, 50, 53))+  
 stat\_compare\_means(label.y = 54)  
print(combin)

## Warning in wilcox.test.default(c(36.9, 34.44, 35.67), c(39.36, 36.9, 44.28:  
## cannot compute exact p-value with ties

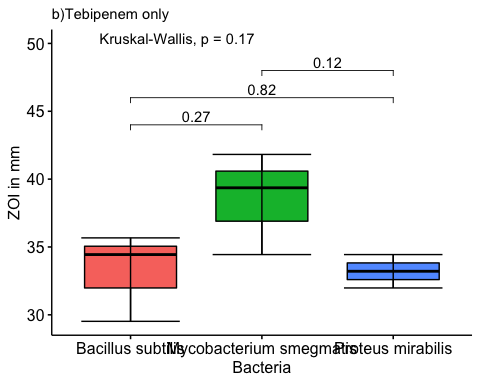


#Make up the boxplot for Tebipenem only on three bacteria  
tebip <- ggboxplot(results,x="Bacteria",y="Tebipenem\_only",fill = "Bacteria")+  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 ) +  
 ggtitle("b)Tebipenem only") +  
 xlab("Bacteria")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 stat\_compare\_means(comparisons = my\_comparisons,  
 label.y = c(44, 46, 48))+  
 stat\_compare\_means(label.y = 50)  
print(tebip)

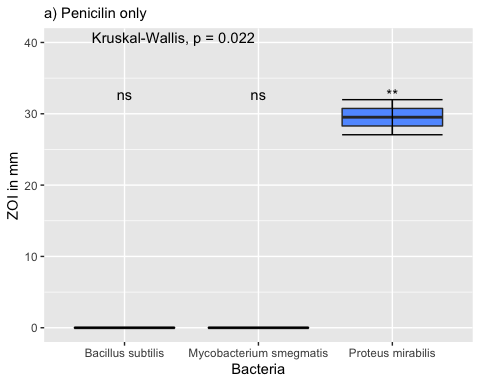
## Warning in wilcox.test.default(c(34.44, 29.52, 35.67), c(39.36, 34.44, 41.82:  
## cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(34.44, 29.52, 35.67), c(33.21, 31.98, 34.44:  
## cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(39.36, 34.44, 41.82), c(33.21, 31.98, 34.44:  
## cannot compute exact p-value with ties



#Make up boxplot for Penicillin only on three bacteria  
p<-results %>%  
 ggplot(aes(x=Bacteria,y=Penicillin\_only,fill=Bacteria))+  
 geom\_boxplot() +  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 ) +  
 ggtitle("a) Penicilin only") +  
 xlab("Bacteria")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 #Cannot compare pairwise because of the zero's  
 stat\_compare\_means(method = "kruskal.test", label.y = 40)+  
 stat\_compare\_means(label = "p.signif", method = "t.test",  
 ref.group = ".all.")  
print(p)



#Compare drug effect on the Bacillus subtilis with a new dataframe + boxplot  
my\_comparisons\_2 <- list(c("Compound combination","Tebipenem only"),  
 c("Compound combination","Penicillin only"),  
 c("Penicillin only","Tebipenem only"))  
Bacillus\_subtilis\_data\_frame <- data.frame(Treatments\_names= c(rep("Compound combination",3),  
 rep("Tebipenem only",3),  
 rep("Penicillin only",3)),  
 Treatment=c(Bacillus\_subtilis\_Combination,  
 Bacillus\_subtilis\_Tebipenem,  
 Bacillus\_subtilis\_Penicilin))  
print(Bacillus\_subtilis\_data\_frame)

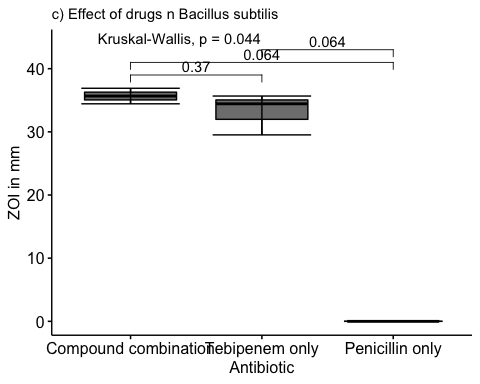
## Treatments\_names Treatment  
## 1 Compound combination 36.90  
## 2 Compound combination 34.44  
## 3 Compound combination 35.67  
## 4 Tebipenem only 34.44  
## 5 Tebipenem only 29.52  
## 6 Tebipenem only 35.67  
## 7 Penicillin only 0.00  
## 8 Penicillin only 0.00  
## 9 Penicillin only 0.00

#Making a boxplot  
Bacillus\_subtilis\_boxplot <-   
 ggboxplot(Bacillus\_subtilis\_data\_frame,x="Treatments\_names",y="Treatment",  
 fill = "Treatment")+  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 ) +  
 ggtitle("c) Effect of drugs n Bacillus subtilis") +  
 xlab("Antibiotic")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 stat\_compare\_means(comparisons = my\_comparisons\_2,  
 label.y = c(39, 41, 43))+  
 stat\_compare\_means(label.y = 44)  
print(Bacillus\_subtilis\_boxplot)

## Warning in wilcox.test.default(c(36.9, 34.44, 35.67), c(34.44, 29.52, 35.67:  
## cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(36.9, 34.44, 35.67), c(0, 0, 0), paired =  
## FALSE): cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(0, 0, 0), c(34.44, 29.52, 35.67), paired =  
## FALSE): cannot compute exact p-value with ties



#Compare drugs effects on Mycobacterium smegmatis (do the same as the previous part)  
Mycobacterium\_smegmatis\_data\_frame <- data.frame(Treatments\_names\_2=  
 c(rep("Compound combination",3),  
 rep("Tebipenem only",3),  
 rep("Penicillin only",3)),  
 Treatment\_2=c(Mycobacterium\_smegmatis\_Combination,  
 Mycobacterium\_smegmatis\_Tebipenem,  
 Mycobacterium\_smegmatis\_Penicilin))  
print(Mycobacterium\_smegmatis\_data\_frame)

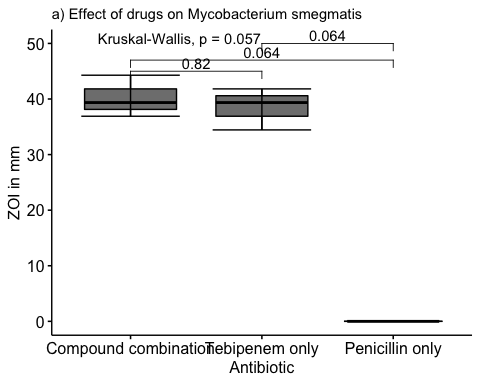
## Treatments\_names\_2 Treatment\_2  
## 1 Compound combination 39.36  
## 2 Compound combination 36.90  
## 3 Compound combination 44.28  
## 4 Tebipenem only 39.36  
## 5 Tebipenem only 34.44  
## 6 Tebipenem only 41.82  
## 7 Penicillin only 0.00  
## 8 Penicillin only 0.00  
## 9 Penicillin only 0.00

Mycobacterium\_smegmatis\_boxplot <-  
 ggboxplot(Mycobacterium\_smegmatis\_data\_frame,x="Treatments\_names\_2",  
 y="Treatment\_2",fill="Treatment\_2")+  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 ) +  
 ggtitle("a) Effect of drugs on Mycobacterium smegmatis") +  
 xlab("Antibiotic")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 stat\_compare\_means(comparisons = my\_comparisons\_2,  
 label.y = c(45, 47 , 50))+  
 stat\_compare\_means(label.y = 50)  
print(Mycobacterium\_smegmatis\_boxplot)

## Warning in wilcox.test.default(c(39.36, 36.9, 44.28), c(39.36, 34.44, 41.82:  
## cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(39.36, 36.9, 44.28), c(0, 0, 0), paired =  
## FALSE): cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(0, 0, 0), c(39.36, 34.44, 41.82), paired =  
## FALSE): cannot compute exact p-value with ties

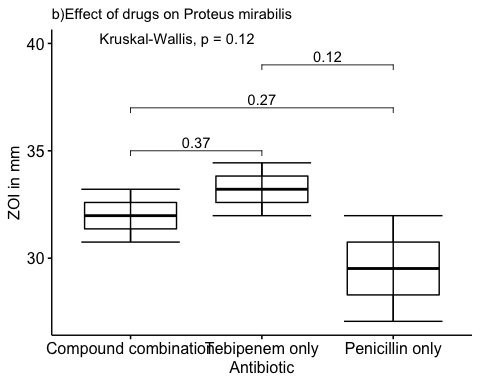


# Compare drugs effects on Proteus mirabilis (do the same as the previous part)  
Proteus\_mirabilis\_dataframe <-data.frame(Treatments\_names\_3=  
 c(rep("Compound combination",3),  
 rep("Tebipenem only",3),  
 rep("Penicillin only",3)),  
 Treatment\_3=c(Proteus\_mirabilis\_Combination,  
 Proteus\_mirabilis\_Tebipenem,  
 Proteus\_mirabilis\_Penicillin))  
Proteus\_mirabilis\_boxplot <-  
 ggboxplot(Proteus\_mirabilis\_dataframe,x="Treatments\_names\_3",  
 y="Treatment\_3",fill="Treatment\_3")+  
 theme(  
 legend.position="none",  
 plot.title = element\_text(size=11)  
 )+  
 ggtitle("b)Effect of drugs on Proteus mirabilis")+  
 xlab("Antibiotic")+  
 ylab("ZOI in mm")+  
 stat\_boxplot(geom = "errorbar")+  
 stat\_compare\_means(comparisons = my\_comparisons\_2,  
 label.y = c(35,37,39))+  
 stat\_compare\_means(label.y = 40)  
print(Proteus\_mirabilis\_boxplot)

## Warning in wilcox.test.default(c(30.75, 31.98, 33.21), c(33.21, 31.98, 34.44:  
## cannot compute exact p-value with ties

## Warning in wilcox.test.default(c(30.75, 31.98, 33.21), c(27.06, 29.52, 31.98:  
## cannot compute exact p-value with ties

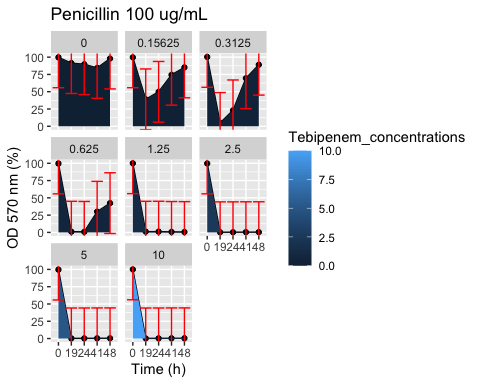
## Warning in wilcox.test.default(c(27.06, 29.52, 31.98), c(33.21, 31.98, 34.44:  
## cannot compute exact p-value with ties



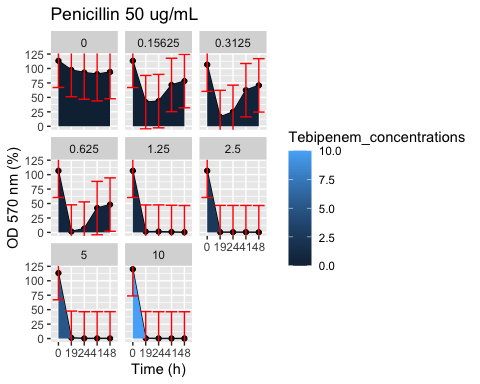
# CHECHERBOARD ASSAY TESTS ANALYSIS   
#BACILLUS SUBTILIS RESULTS AND PLOTS   
#Penicillin 100 ug/mL  
Bacillus\_Penicillin\_100ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values=c(((mean(0.053 , 0.052 , 0.05)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,   
 ((mean(0.054, 0.052, 0.052)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,   
 ((mean(0.054, 0.052, 0.052)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.053,0.054,0.053)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.054,0.044,0.053)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.052,0.054,0.054)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.054,0.054,0.053)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.054,0.055,0.054)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.038, 0.038,0.038)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.038,0.038,0.362)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.038,0.038,0.038)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.041,0.04,0.041)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.041,0.372,0.039)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.055,0.041,0.146)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.181,0.176,0.187)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.374,0.367,0.364)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.038,0.038,0.039)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.038,0.038,0.289)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.038,0.038,0.039)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.041,0.039,0.041)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.04,0.397,0.041)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.118,0.039,0.213)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.212,0.227,0.252)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.352,0.389,0.409)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.038,0.037,0.038)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.038,0.038,0.518)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.038,0.038,0.038)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.04,0.04,0.038)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.193,0.449,0.039)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.4,0.122,0.568)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.426,0.36,0.521)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.478,0.444,0.57)-0.036)/(mean(0.56,0.484,0.59)-0.036))\*100,  
 ((mean(0.038,0.042,0.037)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.038,0.037,0.479)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.038,0.038,0.039)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.039,0.039,0.06)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.244,0.503,0.048)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.473,0.205,0.575)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.454,0.371,0.478)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.517,0.452,0.566)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100))  
print(Bacillus\_Penicillin\_100ug\_data)

## Time Tebipenem\_concentrations Optical\_density\_mean\_values  
## 1 0 10.00000 100.0000000  
## 2 0 5.00000 99.6941896  
## 3 0 2.50000 99.6941896  
## 4 0 1.25000 100.0000000  
## 5 0 0.62500 99.6941896  
## 6 0 0.31250 100.3058104  
## 7 0 0.15625 99.6941896  
## 8 0 0.00000 99.6941896  
## 9 19 10.00000 0.2710027  
## 10 19 5.00000 0.2710027  
## 11 19 2.50000 0.2710027  
## 12 19 1.25000 1.0840108  
## 13 19 0.62500 1.0840108  
## 14 19 0.31250 4.8780488  
## 15 19 0.15625 39.0243902  
## 16 19 0.00000 91.3279133  
## 17 24 10.00000 0.2849003  
## 18 24 5.00000 0.2849003  
## 19 24 2.50000 0.2849003  
## 20 24 1.25000 1.1396011  
## 21 24 0.62500 0.8547009  
## 22 24 0.31250 23.0769231  
## 23 24 0.15625 49.8575499  
## 24 24 0.00000 89.7435897  
## 25 41 10.00000 0.3816794  
## 26 41 5.00000 0.3816794  
## 27 41 2.50000 0.3816794  
## 28 41 1.25000 0.7633588  
## 29 41 0.62500 29.9618321  
## 30 41 0.31250 69.4656489  
## 31 41 0.15625 74.4274809  
## 32 41 0.00000 84.3511450  
## 33 48 10.00000 0.4073320  
## 34 48 5.00000 0.4073320  
## 35 48 2.50000 0.4073320  
## 36 48 1.25000 0.6109980  
## 37 48 0.62500 42.3625255  
## 38 48 0.31250 89.0020367  
## 39 48 0.15625 85.1323829  
## 40 48 0.00000 97.9633401

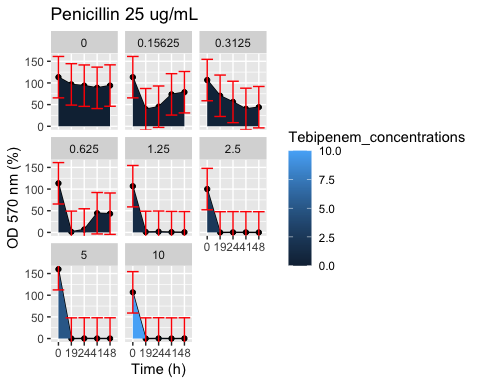
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp1<- Bacillus\_Penicillin\_100ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 100 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_Penicillin\_100ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_Penicillin\_100ug\_data$Optical\_density\_mean\_values),   
 ymax=Bacillus\_Penicillin\_100ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_Penicillin\_100ug\_data$Optical\_density\_mean\_values),col="red")  
print(bp1)



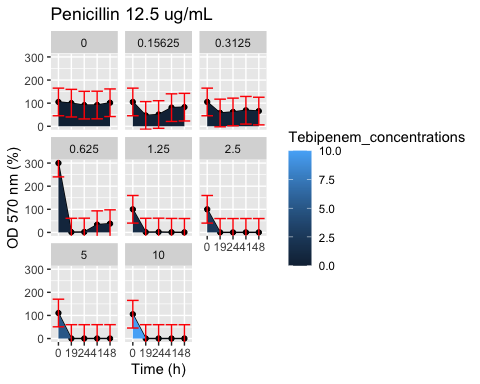
#Penicillin 50 ug/ml  
Bacillus\_subtilis\_50ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values=c(((mean(0.054,0.051,0.05)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.053,0.078,0.052)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.052,0.06,0.052)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.052,0.056,0.053)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.052,0.046,0.054)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.052,0.056,0.054)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.053,0.054,0.055)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.053,0.054,0.054)-0.036)/(mean(0.051,0.052,0.053)-0.036))\*100,  
 ((mean(0.037,0.036,0.036)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.04,0.037,0.049)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.037,0.037,0.04)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.04,0.04,0.041)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.041,0.404,0.041)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.096,0.041,0.105)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.194,0.173,0.219)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.406,0.414,0.414)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.038,0.039,0.049)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.039,0.038,0.042)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.043,0.042,0.044)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.065,0.431,0.043)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.143,0.045,0.158)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.222,0.216,0.262)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.432,0.467,0.442)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.038,0.039,0.038)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.039,0.039,0.047)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.04,0.039,0.041)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.042,0.041,0.041)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.297,0.575,0.044)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.423,0.078,0.467)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.479,0.379,0.51)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.594,0.517,0.632)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.038,0.042,0.059)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.039,0.04,0.048)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.039,0.039,0.041)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.039,0.041,0.041)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.331,0.595,0.06)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.469,0.153,0.506)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.514,0.448,0.54)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.61,0.573,0.643)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp2 <-Bacillus\_subtilis\_50ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 50 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_50ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_50ug\_data$Optical\_density\_mean\_values),   
 ymax=Bacillus\_subtilis\_50ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_50ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp2)



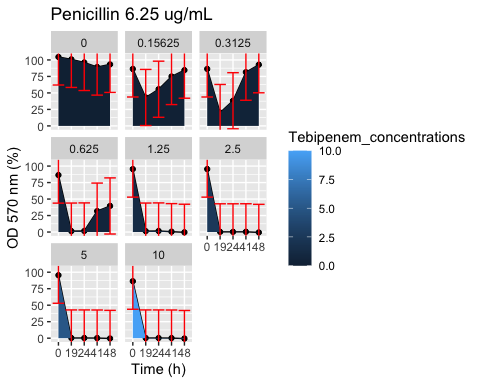
#Penicillin 25 ug/mL  
Bacillus\_subtilis\_25ug\_data <-data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.051,0.05,0.049)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.059,0.05,0.052)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.05,0.051,0.05)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.051,0.053,0.053)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.052,0.051,0.053)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.051,0.053,0.051)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.052,0.054,0.053)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.052,0.053,0.054)-0.035)/(mean(0.05,0.051,0.052)-0.035))\*100,  
 ((mean(0.038,0.039,0.04)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.038,0.039,0.041)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.042,0.043,0.043)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.043,0.385,0.043)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.29,0.044,0.088)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.179,0.173,0.201)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.384,0.402,0.401)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.036,0.068,0.039)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.036,0.037,0.038)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.036,0.037,0.037)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.041,0.042,0.041)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.061,0.384,0.041)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.25,0.041,0.142)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.208,0.212,0.233)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.394,0.405,0.402)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.034,0.049,0.036)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.035,0.036,0.044)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.035,0.036,0.039)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.038,0.04,0.039)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.289,0.543,0.15)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.265,0.079,0.438)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.458,0.338,0.488)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.545,0.409,0.602)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.035,0.055,0.036)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.035,0.037,0.042)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.034,0.068,0.036)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.036,0.038,0.037)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.278,0.557,0.226)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.283,0.145,0.477)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.478,0.417,0.511)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.565,0.5,0.628)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp3 <- Bacillus\_subtilis\_25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_25ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_25ug\_data$Optical\_density\_mean\_values),  
 ymax=Bacillus\_subtilis\_25ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_25ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp3)



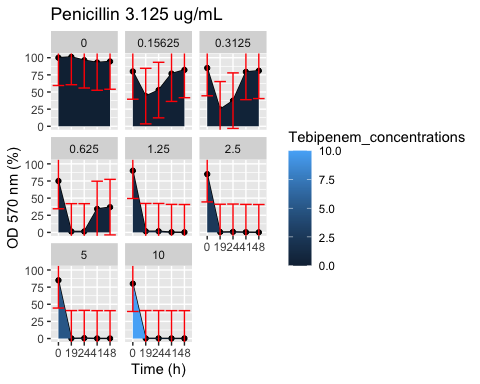
#Penicillin 12.5 ug/mL  
Bacillus\_subtilis\_12.5ug\_data <-data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.058,0.057,0.054)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.059,0.054,0.057)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.057,0.059,0.055)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.057,0.058,0.058)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.057,0.057,0.058-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100),  
 ((mean(0.058,0.061,0.057)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.058,0.061,0.061)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.058,0.06,0.059)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.038,0.038,0.039)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.042,0.043,0.043)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.042,0.396,0.063)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.251,0.044,0.122)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.212,0.194,0.233)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.409,0.41,0.403)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.049,0.042)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.04,0.041)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.039,0.04)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.044,0.044,0.044)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.044,0.389,0.084)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.277,0.043,0.175)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.234,0.234,0.269)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.391,0.395,0.396)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.038,0.054,0.039)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.039,0.041,0.045)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.039,0.039,0.04)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.041,0.042,0.042)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.217,0.505,0.358)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.409,0.142,0.54)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.47,0.339,0.494)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.531,0.393,0.58)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.038,0.059,0.04)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.039,0.04,0.041)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.039,0.086,0.04)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.039,0.04,0.041)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.245,0.533,0.351)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.398,0.241,0.532)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.49,0.408,0.507)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.558,0.483,0.624-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100)))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp4 <- Bacillus\_subtilis\_12.5ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point() +  
 geom\_area()+  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 12.5 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_12.5ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_12.5ug\_data$Optical\_density\_mean\_values),   
 ymax=Bacillus\_subtilis\_12.5ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_12.5ug\_data$Optical\_density\_mean\_values),col="red")  
print(bp4)



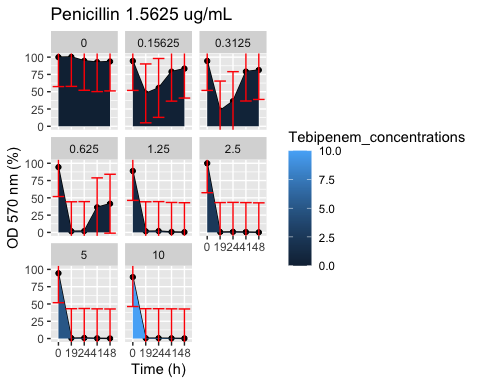
#Penicillin 6.25 ug/mL  
Bacillus\_subtilis\_6.25ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.055,0.055,0.052)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.057,0.053,0.054)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.057,0.056,0.054)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.057,0.061,0.056)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.055,0.054,0.056)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.055,0.055,0.054)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.055,0.058,0.057)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.059,0.055,0.057)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.036,0.036,0.038)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.036,0.037,0.037)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.036,0.037,0.037)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.04,0.04,0.041)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.04,0.403,0.042)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.107,0.042,0.111)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.188,0.183,0.233)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.393,0.411,0.408)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.036,0.037,0.039)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.036,0.037,0.037)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.036,0.037,0.036)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.041,0.041,0.041)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.041,0.391,0.067)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.175,0.041,0.174)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.239,0.224,0.271)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.388,0.394,0.392)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.036,0.097,0.041)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.036,0.037,0.044)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.037,0.038,0.037)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.038,0.212,0.04)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.214,0.516,0.358)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.495,0.14,0.488)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.458,0.33,0.5)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.539,0.374,0.579)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.036,0.104,0.04)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.037,0.038,0.038)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.036,0.038,0.037)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.037,0.216,0.038)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.251,0.517,0.374)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.536,0.257,0.504)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.492,0.392,0.51)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.539,0.464,0.62)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp5<- Bacillus\_subtilis\_6.25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 6.25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_6.25ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_6.25ug\_data$Optical\_density\_mean\_values),  
 ymax=Bacillus\_subtilis\_6.25ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_6.25ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp5)



#Penicillin 3.125 ug/mL  
Bacillus\_subtilis\_3.125ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.053,0.054,0.053)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.054,0.054,0.053)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.054,0.055,0.053)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.055,0.056,0.054)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.052,0.055,0.055)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.054,0.055,0.054)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.053,0.057,0.056)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.057,0.055,0.055)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.037,0.037,0.041)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.037,0.038,0.04)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.038,0.038,0.04)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.042,0.041,0.043)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.041,0.399,0.046)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.123,0.042,0.135)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.191,0.209,0.229)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.392,0.43,0.41)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.037,0.038,0.041)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.038,0.038,0.04)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.039,0.038,0.039)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.042,0.042,0.043)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.041,0.385,0.077)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.169,0.042,0.193)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.224,0.247,0.264)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.379,0.416,0.399)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.037,0.037,0.043)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.037,0.039,0.045)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.038,0.038,0.039)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.038,0.041,0.04)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.223,0.498,0.291)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.47,0.109,0.54)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.456,0.335,0.497)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.545,0.436,0.585)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.037,0.038,0.04)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.037,0.038,0.039)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.037,0.075,0.038)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.037,0.039,0.039)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.239,0.513,0.275)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.482,0.234,0.527)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.489,0.403,0.535)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.557,0.507,0.673)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp6 <- Bacillus\_subtilis\_3.125ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 3.125 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_3.125ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_3.125ug\_data$Optical\_density\_mean\_values),  
 ymax=Bacillus\_subtilis\_3.125ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_3.125ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp6)



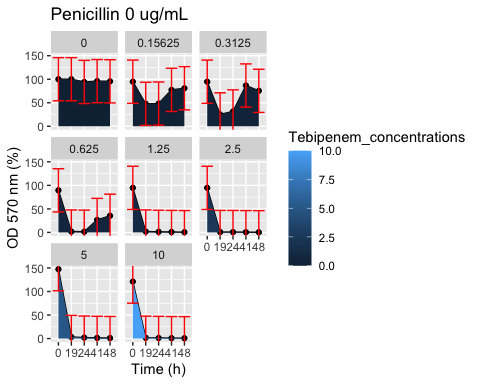
# Penicillin 1.5625  
Bacillus\_subtilis\_1.5625ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.052,0.053,0.053)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.053,0.053,0.052)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.054,0.054,0.052)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.052,0.054,0.054)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.053,0.054,0.054)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.053,0.053,0.054)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.053,0.056,0.054)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.054,0.054,0.054)-0.036)/(0.054-0.036))\*100,  
 ((mean(0.037,0.037,0.039)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.037,0.375,0.038)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.037,0.037,0.039)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.041,0.041,0.042)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.041,0.393,0.043)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.115,0.044,0.116)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.202,0.199,0.229)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.387,0.421,0.398)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.037,0.038,0.039)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.038,0.364,0.038)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.038,0.039,0.038)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.042,0.042,0.041)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.042,0.374,0.041)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.165,0.043,0.171)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.233,0.243,0.259)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.373,0.421,0.388)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.037,0.037,0.04)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.037,0.45,0.038)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.038,0.038,0.038)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.039,0.041,0.039)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.235,0.476,0.266)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.471,0.122,0.548)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.47,0.321,0.503)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.546,0.474,0.583)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.037,0.038,0.038)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.037,0.463,0.038)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.037,0.038,0.037)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.261,0.495,0.341)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.477,0.243,0.556)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.488,0.393,0.532)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.544,0.511,0.63)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp7 <- Bacillus\_subtilis\_1.5625ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 1.5625 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_1.5625ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_1.5625ug\_data$Optical\_density\_mean\_values),  
 ymax=Bacillus\_subtilis\_1.5625ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_1.5625ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp7)



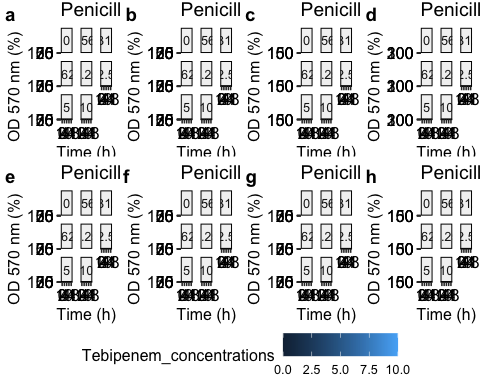
#Penicillin 0 ug/mL  
Bacillus\_subtilis\_0ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.059,0.054,0.054)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.064,0.054,0.055)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.054,0.054,0.053)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.054,0.054,0.054)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.053,0.055,0.055)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.054,0.062,0.054)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.054,0.054,0.054)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.055,0.056,0.055)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.042,0.038,0.038)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.048,0.038,0.039)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.039,0.038,0.039)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.043,0.041,0.045)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.043,0.406,0.044)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.128,0.041,0.127)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.21,0.184,0.229)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.401,0.418,0.42)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.041,0.038,0.038)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.044,0.039,0.039)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.039,0.039,0.039)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.041,0.042,0.042)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.042,0.413,0.042)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.16,0.044,0.189)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.226,0.233,0.266)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.407,0.455,0.414)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.04,0.038,0.038)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.043,0.038,0.04)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.038,0.039,0.038)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.04,0.042,0.04)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.186,0.52,0.277)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.529,0.093,0.567)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.476,0.373,0.534)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.582,0.531,0.606)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.04,0.038,0.073)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.042,0.038,0.066)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.038,0.039,0.092)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.039,0.04,0.041)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.244,0.551,0.27)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.479,0.199,0.562)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.511,0.432,0.592)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100,  
 ((mean(0.598,0.568,0.704)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100))  
print(Bacillus\_subtilis\_0ug\_data)

## Time Tebipenem\_concentrations Optical\_density\_mean\_values  
## 1 0 10.00000 121.0526316  
## 2 0 5.00000 147.3684211  
## 3 0 2.50000 94.7368421  
## 4 0 1.25000 94.7368421  
## 5 0 0.62500 89.4736842  
## 6 0 0.31250 94.7368421  
## 7 0 0.15625 94.7368421  
## 8 0 0.00000 100.0000000  
## 9 19 10.00000 1.6438356  
## 10 19 5.00000 3.2876712  
## 11 19 2.50000 0.8219178  
## 12 19 1.25000 1.9178082  
## 13 19 0.62500 1.9178082  
## 14 19 0.31250 25.2054795  
## 15 19 0.15625 47.6712329  
## 16 19 0.00000 100.0000000  
## 17 24 10.00000 1.2690355  
## 18 24 5.00000 2.0304569  
## 19 24 2.50000 0.7614213  
## 20 24 1.25000 1.2690355  
## 21 24 0.62500 1.5228426  
## 22 24 0.31250 31.4720812  
## 23 24 0.15625 48.2233503  
## 24 24 0.00000 94.1624365  
## 25 41 10.00000 0.8771930  
## 26 41 5.00000 1.4035088  
## 27 41 2.50000 0.5263158  
## 28 41 1.25000 0.8771930  
## 29 41 0.62500 26.4912281  
## 30 41 0.31250 86.6666667  
## 31 41 0.15625 77.3684211  
## 32 41 0.00000 95.9649123  
## 33 48 10.00000 0.6802721  
## 34 48 5.00000 1.0204082  
## 35 48 2.50000 0.3401361  
## 36 48 1.25000 0.5102041  
## 37 48 0.62500 35.3741497  
## 38 48 0.31250 75.3401361  
## 39 48 0.15625 80.7823129  
## 40 48 0.00000 95.5782313

#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
bp8 <-Bacillus\_subtilis\_0ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 0 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Bacillus\_subtilis\_0ug\_data$Optical\_density\_mean\_values-sd(Bacillus\_subtilis\_0ug\_data$Optical\_density\_mean\_values),  
 ymax=Bacillus\_subtilis\_0ug\_data$Optical\_density\_mean\_values+sd(Bacillus\_subtilis\_0ug\_data$Optical\_density\_mean\_values), col="red")  
print(bp8)



#Align all graphs together   
library(ggplot2)  
library(ggpubr)  
theme\_set(theme\_pubr())  
figure <-   
 ggarrange(bp1,bp2,bp3,bp4, bp5, bp6, bp7, bp8,  
 labels=c("a","b","c","d","e","f","g","h"),  
 ncol=4,nrow=2,  
 common.legend = TRUE,legend = "bottom")  
print(figure)



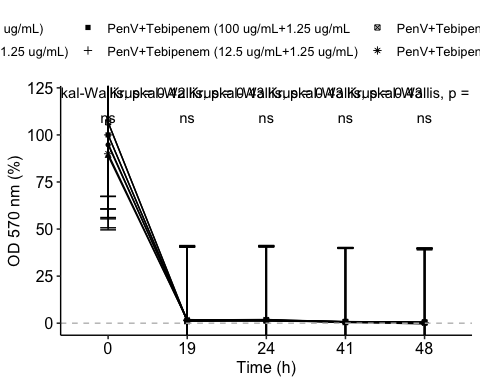
#Final Plot and Data frame that conrain only values that inhibited the growth of the bacteria   
Final\_Bacillus\_data <- data.frame(Time\_f1=c("0","19","24","41","48"),  
 Penicillin\_concentrations= c(rep("PenV+Tebipenem (100 ug/mL+1.25 ug/mL",5),rep("PenV+Tebipenem (50 ug/mL+1.25 ug/mL)",5),  
 rep("PenV+Tebipenem (25 ug/mL+1.25 ug/mL)",5),rep("PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL)",5),  
 rep("PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL)",5),rep("PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL)",5),  
 rep("PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL)",5),rep("PenV+Tebiepenem (0 ug/mL+1.25 ug/mL)",5)),  
 Optical\_density\_values= c(((mean(0.053,0.054,0.053)-0.38)/(mean(0.053,0.054,0.054)-0.38))\*100,  
 ((mean(0.041,0.04,0.041)-mean(0.037,0.038,0.037))/(mean(0.406,0.401,0.392)-mean(0.037,0.038,0.037)))\*100,  
 ((mean(0.041,0.039,0.041)-mean(0.037,0.037,0.038))/(mean(0.388,0.432,0.44)-mean(0.037,0.037,0.038)))\*100,  
 ((mean(0.04,0.04,0.038)-mean(0.036,0.036,0.036))/(mean(0.56,0.484,0.59)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.039,0.039,0.06)-0.036)/(mean(0.527,0.455,0.577)-0.036))\*100,  
 ((mean(0.052,0.056,0.053)-mean(0.036,0.036,0.036))/(mean(0.051,0.052,0.053)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.04,0.04,0.041)-mean(0.035,0.282,0.036))/(mean(0.416,0.428,0.418)-mean(0.035,0.282,0.036)))\*100,  
 ((mean(0.043,0.042,0.044)-mean(0.037,0.402,0.038))/(mean(0.462,0.485,0.457)-mean(0.037,0.402,0.038)))\*100,  
 ((mean(0.042,0.041,0.041)-mean(0.037,0.548,0.037))/(mean(0.655,0.558,0.655)-mean(0.037,0.548,0.037)))\*100,  
 ((mean(0.039,0.041,0.041)-mean(0.037,0.632,0.037))/(mean(0.647,0.596,0.701)-mean(0.037,0.632,0.037)))\*100,  
 ((mean(0.051,0.053,0.053)-mean(0.035,0.035,0.035))/(mean(0.05,0.051,0.052)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.042,0.043,0.043)-mean(0.038,0.038,0.039))/(mean(0.396,0.414,0.404)-mean(0.038,0.038,0.039)))\*100,  
 ((mean(0.041,0.042,0.041)-mean(0.035,0.036,0.037))/(mean(0.418,0.429,0.415)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.038,0.04,0.039)-mean(0.034,0.035,0.035))/(mean(0.61,0.489,0.61)-mean(0.034,0.035,0.035)))\*100,  
 ((mean(0.036,0.038,0.037)-mean(0.034,0.036,0.035))/(mean(0.599,0.542,0.667)-mean(0.034,0.036,0.035)))\*100,  
 ((mean(0.057,0.058,0.058)-mean(0.038,0.039,0.038))/(mean(0.057,0.056,0.057)-mean(0.038,0.039,0.038)))\*100,  
 ((mean(0.042,0.043,0.043)-mean(0.037,0.038,0.038))/(mean(0.409,0.422,0.416)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.044,0.044,0.044)-mean(0.037,0.038,0.038))/(mean(0.424,0.42,0.409)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.041,0.042,0.042)-mean(0.037,0.039,0.038))/(mean(0.574,0.503,0.604)-mean(0.037,0.039,0.038)))\*100,  
 ((mean(0.039,0,04,0.041)-mean(0.037,0.038,0.038))/(mean(0.585,0.531,0.654)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.057,0.061,0.056)-mean(0.036,0.036,0.039))/(mean(0.058,0.056,0.057)-mean(0.036,0.036,0.039)))\*100,  
 ((mean(0.04,0.04,0.041)-mean(0.035,0.036,0.035))/(mean(0.39,0.421,0.423)-mean(0.035,0.036,0.035)))\*100,  
 ((mean(0.041,0.041,0.041)-mean(0.035,0.039,0.036))/(mean(0.402,0.412,0.413)-mean(0.035,0.039,0.036)))\*100,  
 ((mean(0.038,0.212,0.04)-mean(0.035,0.037,0.036))/(mean(0.6,0.501,0.608)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.037,0.216,0.038)-mean(0.039,0.037,0.036))/(mean(0.575,0.515,0.644)-mean(0.039,0.037,0.036)))\*100,  
 ((mean(0.055,0.056,0.054)-mean(0.037,0.037,0.037))/(mean(0.057,0.056,0.056)-mean(0.037,0.037,0.037)))\*100,  
 ((mean(0.042,0.041,0.043)-mean(0.036,0.308,0.303))/(mean(0.388,0.421,0.414)-mean(0.036,0.308,0.303)))\*100,  
 ((mean(0.042,0.042,0.043)-mean(0.036,0.383,0.384))/(mean(0.392,0.425,0.411)-mean(0.036,0.383,0.384)))\*100,  
 ((mean(0.038,0.041,0.04)-mean(0.036,0.421,0.63))/(mean(0.583,0.515,0.608)-mean(0.036,0.421,0.63)))\*100,  
 ((mean(0.037,0.039,0.039)-mean(0.036,0.534,0.546))/(mean(0.587,0.548,0.66)-mean(0.036,0.534,0.546)))\*100,  
 ((mean(0.052,0.054,0.054)-mean(0.036,0.036,0.036))/(mean(0.054,0.054,0.054)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.041,0.041,0.042)-mean(0.035,0.358,0.036))/(mean(0.386,0.411,0.412)-mean(0.035,0.358,0.036)))\*100,  
 ((mean(0.042,0.042,0.041)-mean(0.035,0.431,0.038))/(mean(0.392,0.441,0.403)-mean(0.035,0.431,0.038)))\*100,  
 ((mean(0.039,0.041,0.039)-mean(0.035,0.54,0.036))/(mean(0.586,0.522,0.609)-mean(0.035,0.54,0.036)))\*100,  
 ((mean(0.038,0.039,0.039)-mean(0.036,0.607,0.037))/(mean(0.578,0.555,0.578)-mean(0.036,0.607,0.037)))\*100,  
 ((mean(0.054,0.054,0.054)-0.036)/(0.055-0.036))\*100,  
 ((mean(0.043,0.041,0.045)-mean(0.036,0.036,0.037))/(mean(0.401,0.422,0.438)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.041,0.042,0.042)-mean(0.036,0.037,0.037))/(mean(0.43,0.475,0.435)-mean(0.036,0.037,0.037)))\*100,  
 ((mean(0.04,0.042,0.04)-mean(0.035,0.037,0.036))/(mean(0.605,0.566,0.636)-mean(0.035,0.037,0.036)))\*100,  
 ((mean(0.039,0.04,0.041)-mean(0.036,0.038,0.036))/(mean(0.624,0.604,0.625)-mean(0.036,0.038,0.036)))\*100))  
print(Final\_Bacillus\_data)

## Time\_f1 Penicillin\_concentrations Optical\_density\_values  
## 1 0 PenV+Tebipenem (100 ug/mL+1.25 ug/mL 100.0000000  
## 2 19 PenV+Tebipenem (100 ug/mL+1.25 ug/mL 1.0840108  
## 3 24 PenV+Tebipenem (100 ug/mL+1.25 ug/mL 1.1396011  
## 4 41 PenV+Tebipenem (100 ug/mL+1.25 ug/mL 0.7633588  
## 5 48 PenV+Tebipenem (100 ug/mL+1.25 ug/mL 0.6109980  
## 6 0 PenV+Tebipenem (50 ug/mL+1.25 ug/mL) 106.6666667  
## 7 19 PenV+Tebipenem (50 ug/mL+1.25 ug/mL) 1.3123360  
## 8 24 PenV+Tebipenem (50 ug/mL+1.25 ug/mL) 1.4117647  
## 9 41 PenV+Tebipenem (50 ug/mL+1.25 ug/mL) 0.8090615  
## 10 48 PenV+Tebipenem (50 ug/mL+1.25 ug/mL) 0.3278689  
## 11 0 PenV+Tebipenem (25 ug/mL+1.25 ug/mL) 106.6666667  
## 12 19 PenV+Tebipenem (25 ug/mL+1.25 ug/mL) 1.1173184  
## 13 24 PenV+Tebipenem (25 ug/mL+1.25 ug/mL) 1.5665796  
## 14 41 PenV+Tebipenem (25 ug/mL+1.25 ug/mL) 0.6944444  
## 15 48 PenV+Tebipenem (25 ug/mL+1.25 ug/mL) 0.3539823  
## 16 0 PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL) 100.0000000  
## 17 19 PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL) 1.3440860  
## 18 24 PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL) 1.8087855  
## 19 41 PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL) 0.7448790  
## 20 48 PenV+Tebipenem (12.5 ug/mL+1.25 ug/mL) 0.3649635  
## 21 0 PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL) 95.4545455  
## 22 19 PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL) 1.4084507  
## 23 24 PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL) 1.6348774  
## 24 41 PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL) 0.5309735  
## 25 48 PenV+Tebipenem (6.25 ug/mL+1.25 ug/mL) -0.3731343  
## 26 0 PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL) 90.0000000  
## 27 19 PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL) 1.7045455  
## 28 24 PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL) 1.6853933  
## 29 41 PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL) 0.3656307  
## 30 48 PenV+Tebipenem (3.125 ug/mL+1.25 ug/mL) 0.1814882  
## 31 0 PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL) 88.8888889  
## 32 19 PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL) 1.7094017  
## 33 24 PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL) 1.9607843  
## 34 41 PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL) 0.7259528  
## 35 48 PenV+Tebipenem (1.5625 ug/mL+1.25 ug/mL) 0.3690037  
## 36 0 PenV+Tebiepenem (0 ug/mL+1.25 ug/mL) 94.7368421  
## 37 19 PenV+Tebiepenem (0 ug/mL+1.25 ug/mL) 1.9178082  
## 38 24 PenV+Tebiepenem (0 ug/mL+1.25 ug/mL) 1.2690355  
## 39 41 PenV+Tebiepenem (0 ug/mL+1.25 ug/mL) 0.8771930  
## 40 48 PenV+Tebiepenem (0 ug/mL+1.25 ug/mL) 0.5102041

#Line graph   
Final\_Bac <- Final\_Bacillus\_data %>%  
 ggplot(aes(x=Time\_f1, y=Optical\_density\_values, group=Penicillin\_concentrations, shape=Penicillin\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 stat\_compare\_means(method = "kruskal.test", label.y =120)+  
 stat\_compare\_means(label = "p.signif")+  
 geom\_errorbar(ymin=Final\_Bacillus\_data$Optical\_density\_values-sd(Final\_Bacillus\_data$Optical\_density\_values),  
 ymax=Final\_Bacillus\_data$Optical\_density\_values+sd(Final\_Bacillus\_data$Optical\_density\_values),  
 width=.2)+  
 geom\_hline(yintercept = 0, linetype="dashed", col="grey")  
print(Final\_Bac)

## Warning: The shape palette can deal with a maximum of 6 discrete values because  
## more than 6 becomes difficult to discriminate; you have 8. Consider  
## specifying shapes manually if you must have them.

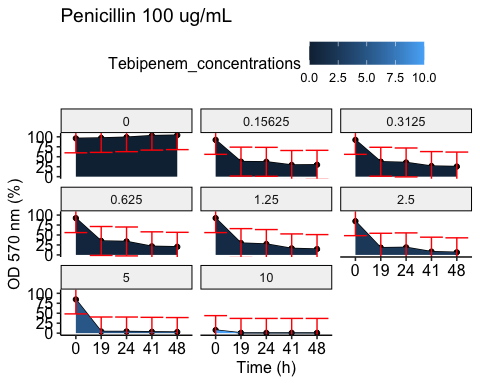
## Warning: Removed 10 rows containing missing values (geom\_point).



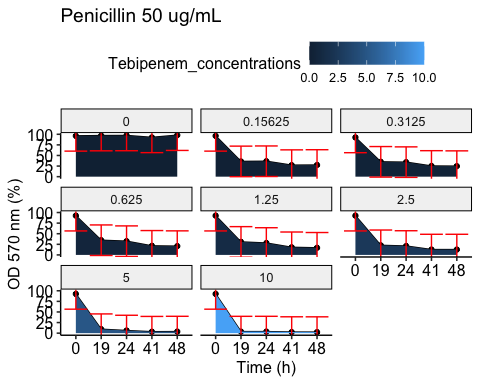
#PROTEUS MIRABILIS RESULTS AND PLOTS  
#Penicillin 100 ug/mL  
Proteus\_mirabilis\_100ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.04, 0.06, 0.806)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.06,0.061, 0.061)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.06,0.061,0.061)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.062,0.061,0.061)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.062,0.061,0.066)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.062,0.061,0.064)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.062,0.061,0.061)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.063,0.062,0.062)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.04,0.049,0.051)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.05,0.06,0.054)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.089,0.1,0.093)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.122,0.127,0.121)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.137,0.152,0.141)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.144,0.159,0.146)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.145,0.161,0.14)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.313,0.319,0.321)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.04,0.048,0.043)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.051,0.052,0.051)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.097,0.1,0.098)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.123,0.125,0.12)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.143,0.149,0.139)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.149,0.159,0.149)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.154,0.167,0.15)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.346,0.344,0.337)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.041,0.049,0.039)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.053,0.053,0.051)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.074,0.081,0.081)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.11,0.114,0.11)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.133,0.152,0.14)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.155,0.182,0.157)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.167,0.201,0.165)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.49,0.494,0.416)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.041,0.048,0.036)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.051,0.051,0.052)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.068,0.075,0.085)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.105,0.109,0.111)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.131,0.144,0.141)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.154,0.176,0.161)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.174,0.206,0.186)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.513,0.501,0.49)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100))  
print(Proteus\_mirabilis\_100ug\_data)

## Time Tebipenem\_concentrations Optical\_density\_mean\_values  
## 1 0 10.00000 7.6923077  
## 2 0 5.00000 84.6153846  
## 3 0 2.50000 84.6153846  
## 4 0 1.25000 92.3076923  
## 5 0 0.62500 92.3076923  
## 6 0 0.31250 92.3076923  
## 7 0 0.15625 92.3076923  
## 8 0 0.00000 96.1538462  
## 9 19 10.00000 0.7067138  
## 10 19 5.00000 4.2402827  
## 11 19 2.50000 18.0212014  
## 12 19 1.25000 29.6819788  
## 13 19 0.62500 34.9823322  
## 14 19 0.31250 37.4558304  
## 15 19 0.15625 37.8091873  
## 16 19 0.00000 97.1731449  
## 17 24 10.00000 0.6430868  
## 18 24 5.00000 4.1800643  
## 19 24 2.50000 18.9710611  
## 20 24 1.25000 27.3311897  
## 21 24 0.62500 33.7620579  
## 22 24 0.31250 35.6913183  
## 23 24 0.15625 37.2990354  
## 24 24 0.00000 99.0353698  
## 25 41 10.00000 0.6833713  
## 26 41 5.00000 3.4168565  
## 27 41 2.50000 8.2004556  
## 28 41 1.25000 16.4009112  
## 29 41 0.62500 21.6400911  
## 30 41 0.31250 26.6514806  
## 31 41 0.15625 29.3849658  
## 32 41 0.00000 102.9612756  
## 33 48 10.00000 0.6578947  
## 34 48 5.00000 2.8508772  
## 35 48 2.50000 6.5789474  
## 36 48 1.25000 14.6929825  
## 37 48 0.62500 20.3947368  
## 38 48 0.31250 25.4385965  
## 39 48 0.15625 29.8245614  
## 40 48 0.00000 104.1666667

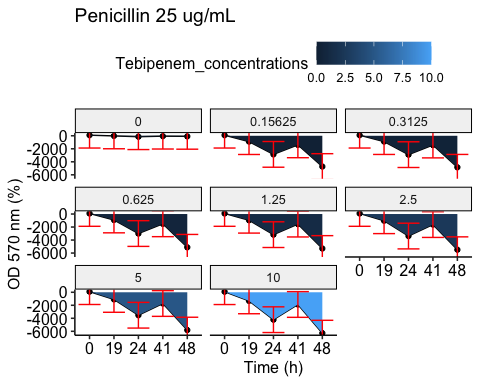
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp1 <- Proteus\_mirabilis\_100ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area()+  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 100 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_100ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_100ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_100ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_100ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp1)



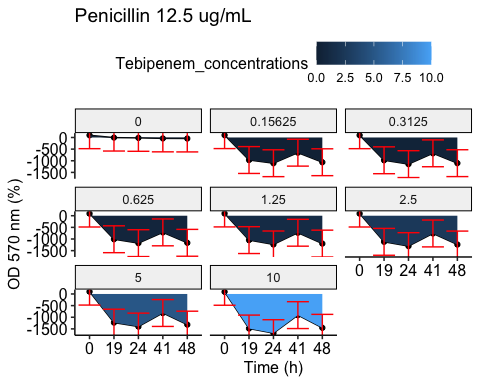
#Penicillin 50 ug/mL  
Proteus\_mirabilis\_50ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.06,0.06,0.04)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.06,0.06,0.06)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.06,0.061,0.06)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.06,0.06,0.061)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.06,0.06,0.06)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.06,0.06,0.061)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.061,0.06,0.059)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.061,0.06,0.06)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.046,0.048,0.194)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.063,0.097,0.069)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.103,0.108,0.106)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.127,0.129,0.124)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.139,0.143,0.137)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.14,0.15,0.138)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.143,0.154,0.143)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.326,0.341,0.327)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.049,0.051,0.239)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.057,0.1,0.067)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.105,0.11,0.11)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.128,0.129,0.127)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.142,0.145,0.144)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.148,0.156,0.147)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.155,0.166,0.154)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.352,0.346,0.337)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.05,0.052,0.239)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.054,0.082,0.056)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.097,0.104,0.104)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.122,0.125,0.12)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.138,0.149,0.145)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.156,0.176,0.159)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.165,0.19,0.162)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.471,0.504,0.413)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.05,0.051,0.168)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.056,0.083,0.061)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.099,0.107,0.109)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.119,0.121,0.12)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.138,0.148,0.147)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.158,0.177,0.162)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.171,0.2,0.171)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.511,0.525,0.474)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp2 <- Proteus\_mirabilis\_50ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 50 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_50ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_50ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_50ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_50ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp2)



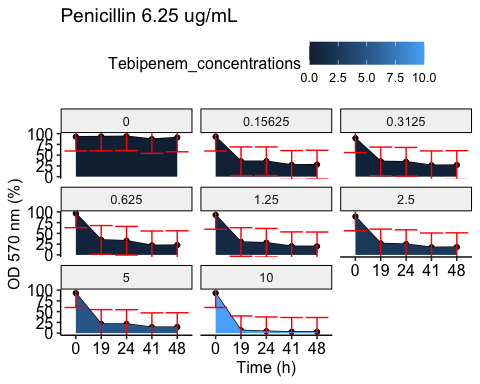
#Penicillin 25 ug/mL  
Proteus\_mirabilis\_25ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.058,0.057,0.056)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.06,0.057,0.06)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.058,0.056,0.058)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.058,0.057,0.059)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.058,0.058,0.058)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.059,0.062,0.057)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.059,0.057,0.057)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.059,0.058,0.057)-0.035)/(mean(0.061,0.061,0.066)-0.035))\*100,  
 ((mean(0.05,0.05,0.05)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.095,0.09,0.094)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.108,0.106,0.109)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.124,0.127,0.12)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.132,0.137,0.133)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.136,0.144,0.132)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.135,0.144,0.136)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.311,0.333,0.32)-mean(0.315,0.038,0.318))/(mean(0.335,0.333,0.368)-mean(0.315,0.038,0.318)))\*100,  
 ((mean(0.048,0.048,0.046)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.096,0.089,0.098)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.106,0.103,0.109)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.121,0.124,0.122)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.133,0.136,0.136)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.14,0.146,0.135)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.143,0.152,0.144)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.333,0.335,0.324)-mean(0.343,0.036,0.351))/(mean(0.35,0.337,0.37)-mean(0.343,0.036,0.351)))\*100,  
 ((mean(0.047,0.048,0.046)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.08,0.055,0.088)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.103,0.102,0.104)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.119,0.12,0.117)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.129,0.137,0.135)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.147,0.162,0.147)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.153,0.175,0.152)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.447,0.489,0.399)-mean(0.46,0.035,0.456))/(mean(0.482,0.504,0.443)-mean(0.46,0.035,0.456)))\*100,  
 ((mean(0.048,0.048,0.046)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.081,0.057,0.09)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.104,0.104,0.108)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.117,0.117,0.117)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.13,0.137,0.137)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.149,0.163,0.149)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.157,0.179,0.157)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100,  
 ((mean(0.482,0.495,0.45)-mean(0.488,0.035,0.506))/(mean(0.495,0.5,0.474)-mean(0.488,0.035,0.506)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp3 <- Proteus\_mirabilis\_25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_25ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_25ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_25ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_25ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp3)



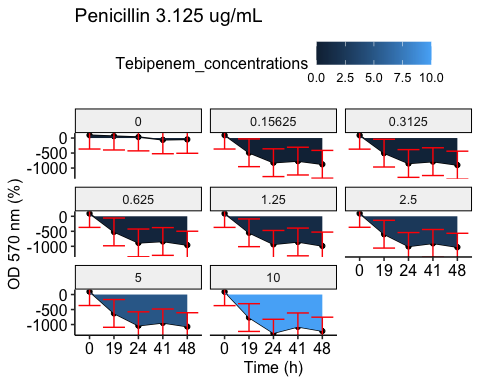
#Penicillin 12.5 ug/mL  
Proteus\_mirabilis\_12.5ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.063,0.065,0.062)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.065,0.065,0.064)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.063,0.064,0.064)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.064,0.063,0.064)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.063,0.064,0.063)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((0.064-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.065,0.064,0.063)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.064,0.063,0.063)-0.038)/(mean(0.065,0.066,0.063)-0.038))\*100,  
 ((mean(0.052,0.053,0.053)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.1,0.104,0.103)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.121,0.117,0.114)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.135,0.137,0.131)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.142,0.149,0.143)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.148,0.153,0.148)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.15,0.157,0.15)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.333,0.35,0.331)-mean(0.334,0.038,0.321))/(mean(0.353,0.358,0.339)-mean(0.334,0.038,0.321)))\*100,  
 ((mean(0.052,0.053,0.051)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.103,0.105,0.107)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.12,0.117,0.117)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.133,0.135,0.134)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.143,0.148,0.147)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.149,0.156,0.151)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.156,0.167,0.158)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.352,0.351,0.334)-mean(0.355,0.038,0.372))/(mean(0.373,0.353,0.344)-mean(0.355,0.038,0.372)))\*100,  
 ((mean(0.053,0.054,0.053)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.094,0.091,0.104)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.119,0.115,0.111)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.133,0.132,0.129)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.14,0.148,0.149)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.156,0.169,0.16)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.168,0.185,0.166)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.444,0.492,0.405)-mean(0.462,0.038,0.473))/(mean(0.507,0.508,0.422)-mean(0.462,0.038,0.473)))\*100,  
 ((mean(0.054,0.054,0.055)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.095,0.093,0.103)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.119,0.117,0.115)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.131,0.13,0.128)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.141,0.149,0.15)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.159,0.171,0.162)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.171,0.187,0.171)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100,  
 ((mean(0.477,0.501,0.447)-mean(0.49,0.038,0.506))/(mean(0.52,0.504,0.478)-mean(0.49,0.038,0.506)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp4 <- Proteus\_mirabilis\_12.5ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 12.5 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_12.5ug\_data $Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_12.5ug\_data $Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_12.5ug\_data $Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_12.5ug\_data $Optical\_density\_mean\_values), col="red")  
print(Pp4)



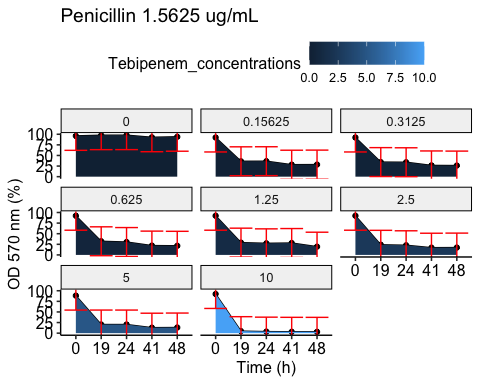
#Penicillin 6.25 ug/mL  
Proteus\_mirabilis\_6.25ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.062,0.063,0.061)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.062,0.065,0.062)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.061,0.062,0.062)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.062,0.063,0.063)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.063,0.062,0.063)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.061,0.062,0.062)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.062,0.062,0.061)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.062,0.062,0.063)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.057,0.057,0.05)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.105,0.106,0.107)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.122,0.121,0.117)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.133,0.143,0.135)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.149,0.155,0.149)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.151,0.156,0.153)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.152,0.165,0.157)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.339,0.351,0.349)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.05,0.051,0.05)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.108,0.106,0.109)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.121,0.122,0.119)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.132,0.141,0.138)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.148,0.154,0.153)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.154,0.16,0.156)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.158,0.173,0.164)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.357,0.353,0.342)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.051,0.052,0.052)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.102,0.097,0.111)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.12,0.121,0.115)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.132,0.135,0.131)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.142,0.151,0.152)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.162,0.172,0.164)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.166,0.189,0.169)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.451,0.475,0.407)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.051,0.052,0.055)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.105,0.101,0.113)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.124,0.125,0.121)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.133,0.135,0.134)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.147,0.154,0.157)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.168,0.178,0.171)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.173,0.194,0.177)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.479,0.493,0.453)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp5 <- Proteus\_mirabilis\_6.25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 6.25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_6.25ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_6.25ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_6.25ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_6.25ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp5)



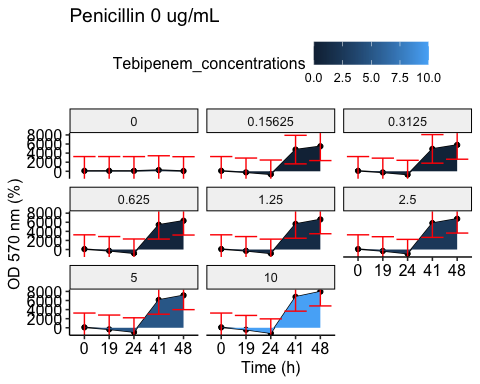
#Penicillin 3.125 ug/mL  
Proteus\_mirabilis\_3.125ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.061,0.063,0.06)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.062,0.062,0.062)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.062,0.061,0.062)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.061,0.062,0.062)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.061,0.062,0.063)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.061,0.061,0.063)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.062,0.061,0.061)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.062,0.06,0.063)-mean(0.037,0.036,0.037))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.057,0.054,0.052)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.104,0.106,0.105)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.115,0.118,0.114)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.131,0.137,0.131)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.141,0.151,0.141)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.147,0.151,0.143)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.151,0.159,0.151)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.34,0.352,0.339)-mean(0.318,0.038,0.036))/(mean(0.352,0.368,0.355)-mean(0.318,0.038,0.036)))\*100,  
 ((mean(0.05,0.052,0.052)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.107,0.107,0.108)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.115,0.12,0.118)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.131,0.136,0.134)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.142,0.151,0.146)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.151,0.158,0.15)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.157,0.169,0.159)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.354,0.347,0.332)-mean(0.346,0.036,0.036))/(mean(0.369,0.36,0.348)-mean(0.346,0.036,0.036)))\*100,  
 ((mean(0.051,0.053,0.052)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.101,0.099,0.111)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.117,0.122,0.116)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.135,0.135,0.131)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.141,0.153,0.149)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.161,0.171,0.162)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.168,0.185,0.168)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.437,0.475,0.402)-mean(0.46,0.038,0.037))/(mean(0.498,0.501,0.42)-mean(0.46,0.038,0.037)))\*100,  
 ((mean(0.052,0.053,0.053)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.104,0.103,0.112)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.118,0.122,0.12)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.132,0.132,0.13)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.142,0.154,0.151)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.163,0.176,0.164)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.172,0.185,0.171)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100,  
 ((mean(0.462,0.482,0.437)-mean(0.478,0.037,0.036))/(mean(0.513,0.504,0.474)-mean(0.478,0.037,0.036)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp6 <- Proteus\_mirabilis\_3.125ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 3.125 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_3.125ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_3.125ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_3.125ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_3.125ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp6)



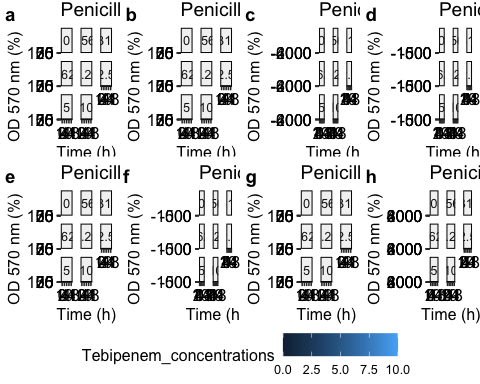
#Penicillin 1.5625 ug/mL  
Proteus\_mirabilis\_1.5625ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.06,0.063,0.059)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.059,0.062,0.06)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.06,0.06,0.06)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.06,0.06,0.061)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.06,0.06,0.061)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.06,0.06,0.061)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.06,0.06,0.06)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.061,0.06,0.061)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.051,0.054,0.051)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.1,0.106,0.102)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.111,0.115,0.112)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.127,0.133,0.127)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.137,0.139,0.345)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.144,0.152,0.138)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.15,0.157,0.142)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.343,0.349,0.341)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.049,0.051,0.053)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.104,0.108,0.112)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.112,0.117,0.116)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.127,0.133,0.13)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.137,0.14,0.337)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.149,0.158,0.147)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.157,0.167,0.154)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.359,0.347,0.335)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.052,0.053,0.053)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.097,0.102,0.111)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.116,0.119,0.116)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.13,0.132,0.129-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100),  
 ((mean(0.139,0.138,0.406)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.16,0.173,0.158)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.168,0.183,0.163)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.467,0.502,0.408)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.052,0.052,0.052)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.1,0.105,0.109)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.119,0.123,0.119)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.129,0.13,0.13)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.139,0.136,0.427)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.161,0.174,0.16)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.172,0.187,0.166)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100,  
 ((mean(0.482,0.478,0.44)-mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp7 <- Proteus\_mirabilis\_1.5625ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 1.5625 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_1.5625ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_1.5625ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_1.5625ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_1.5625ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp7)



#Penicillin 0 ug/mL  
Proteus\_mirabilis\_0ug\_data <- data.frame(Time= c(rep("0",8),rep("19",8),rep("24",8),rep("41",8),rep("48",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.062,0.066,0.062)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.064,0.062)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.063,0.063)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.062,0.063)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.061,0.061,0.063)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.063,0.063)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.061,0.062)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.062,0.061,0.063)-mean(0.037,0.036,0.036))/(mean(0.063,0.064,0.063)-mean(0.037,0.036,0.036)))\*100,  
 ((mean(0.055,0.055,0.051)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.107,0.108,0.104)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.12,0.12,0.116)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.139,0.139,0.137)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.142,0.157,0.375)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.164,0.168,0.162)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.176,0.183,0.165)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.377,0.38,0.375)-mean(0.317,0.036,0.036))/(mean(0.378,0.386,0.366)-mean(0.317,0.036,0.036)))\*100,  
 ((mean(0.051,0.054,0.053)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.113,0.109,0.11)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.122,0.122,0.121)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.137,0.139,0.14)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.145,0.16,0.357)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.17,0.176,0.169)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.186,0.196,0.174)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.382,0.376,0.359)-mean(0.359,0.037,0.038))/(mean(0.385,0.383,0.36)-mean(0.359,0.037,0.038)))\*100,  
 ((mean(0.052,0.054,0.053)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.099,0.1,0.112)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.121,0.121,0.12)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.134,0.134,0.137)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.147,0.164,0.422)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.183,0.192,0.181)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.194,0.215,0.188)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.509,0.562,0.426)-mean(0.528,0.038,0.038))/(mean(0.521,0.578,0.422)-mean(0.528,0.038,0.038)))\*100,  
 ((mean(0.052,0.053,0.052)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.101,0.104,0.113)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.123,0.126,0.124)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.132,0.137,0.137)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.149,0.168,0.445)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.181,0.194,0.184)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.199,0.23,0.199)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100,  
 ((mean(0.525,0.519,0.471)-mean(0.529,0.037,0.038))/(mean(0.523,0.523,0.485)-mean(0.529,0.037,0.038)))\*100))  
  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Pp8 <- Proteus\_mirabilis\_0ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 0 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Proteus\_mirabilis\_0ug\_data$Optical\_density\_mean\_values-sd(Proteus\_mirabilis\_0ug\_data$Optical\_density\_mean\_values),  
 ymax=Proteus\_mirabilis\_0ug\_data$Optical\_density\_mean\_values+sd(Proteus\_mirabilis\_0ug\_data$Optical\_density\_mean\_values), col="red")  
print(Pp8)



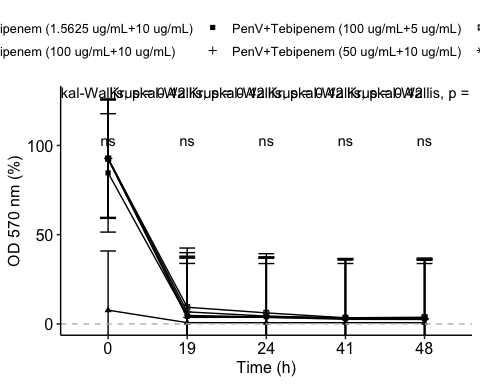
#Align all graphs together   
library(ggplot2)  
library(ggpubr)  
theme\_set(theme\_pubr())  
figure\_2 <- ggarrange(Pp1,Pp2,Pp3,Pp4, Pp5, Pp6, Pp7, Pp8,  
 labels=c("a","b","c","d","e","f","g","h"),  
 ncol=4,nrow=2,  
 common.legend = TRUE,legend = "bottom")  
print(figure\_2)



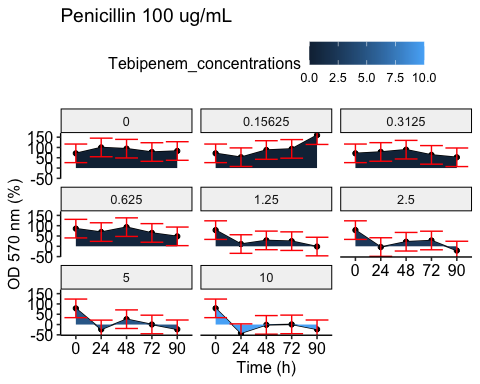
#Compare concentrations that inhibt the bacterial growth   
Final\_Proteus\_data <- data.frame(Time\_f2 =c("0","19","24","41","48"),  
 Concentrations= c(rep("PenV+Tebipenem (100 ug/mL+10 ug/mL)",5),rep("PenV+Tebipenem (100 ug/mL+5 ug/mL)",5),  
 rep("PenV+Tebipenem (50 ug/mL+10 ug/mL)",5),rep("PenV+Tebipenem (50 ug/mL+5 ug/mL)",5),  
 rep("PenV+Tebipenem (6.25 ug/mL+10 ug/mL)",5),rep("PenV+Tebipenem (1.5625 ug/mL+10 ug/mL)",5)),  
 Optical\_density=c(((mean(0.04,0.06,0.806)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.04,0.049,0.051)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.04,0.048,0.043)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.041,0.049,0.039)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.041,0.048,0.036)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.06,0.061,0.061)-0.038)/(mean(0.064,0.063,0.062)-0.038))\*100,  
 ((mean(0.05,0.06,0.054)-mean(0.038,0.037,0.037))/(mean(0.321,0.32,0.324)-mean(0.038,0.037,0.037)))\*100,  
 ((mean(0.051,0.052,0.051)-mean(0.038,0.037,0.038))/(mean(0.349,0.335,0.334)-mean(0.038,0.037,0.038)))\*100,  
 ((mean(0.053,0.053,0.051)-mean(0.038,0.036,0.037))/(mean(0.477,0.471,0.411)-mean(0.038,0.036,0.037)))\*100,  
 ((mean(0.051,0.051,0.052)-mean(0.038,0.036,0.036))/(mean(0.494,0.454,0.501)-mean(0.038,0.036,0.036)))\*100,  
 ((mean(0.06,0.06,0.04)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.046,0.048,0.194)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325,)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.049,0.051,0.239)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.05,0.052,0.239)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.05,0.051,0.168)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.06,0.06,0.06)-mean(0.035,0.036,0.037))/(mean(0.062,0.063,0.061)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.063,0.097,0.069)-mean(0.035,0.036,0.037))/(mean(0.335,0.338,0.325)-mean(0.035,0.036,0.037)))\*100,  
 ((mean(0.057,0.1,0.067)-mean(0.037,0.038,0.038))/(mean(0.361,0.339,0.336)-mean(0.037,0.038,0.038)))\*100,  
 ((mean(0.054,0.082,0.056)-0.038)/(mean(0.505,0.514,0.419)-0.038))\*100,  
 ((mean(0.056,0.083,0.061)-0.038)/(mean(0.521,0.515,0.491)-0.038))\*100,  
 ((mean(0.062,0.063,0.061)-0.036)/(mean(0.064,0.065,0.063)-0.036))\*100,  
 ((mean(0.057,0.057,0.05)-mean(0.035,0.035,0.338))/(mean(0.361,0.368,0.352)-mean(0.035,0.035,0.338)))\*100,  
 ((mean(0.05,0.051,0.05)-mean(0.035,0.037,0.366))/(mean(0.378,0.365,0.352)-mean(0.035,0.037,0.366)))\*100,  
 ((mean(0.051,0.052,0.052)-mean(0.036,0.037,0.469))/(mean(0.511,0.503,0.425)-mean(0.036,0.037,0.469)))\*100,  
 ((mean(0.051,0.052,0.055)-mean(0.036,0.037,0.49))/(mean(0.523,0.494,0.479)-mean(0.036,0.037,0.49)))\*100,  
 ((mean(0.06,0.063,0.059)-0.036)/(mean(0.062,0.061,0.061)-0.036))\*100,  
 ((mean(0.051,0.054,0.051)-0.036)/(mean(0.35,0.362,0.349)-0.036))\*100,  
 ((mean(0.049,0.051,0.053)-mean(0.037,0.036,0.037))/(mean(0.366,0.361,0.345)-mean(0.037,0.036,0.037)))\*100,  
 ((mean(0.052,0.053,0.053)-mean(0.037,0.037,0.036))/(mean(0.5,0.521,0.42)-mean(0.037,0.037,0.036)))\*100,  
 ((0.052- mean(0.037,0.037,0.036))/(mean(0.51,0.503,0.469)-mean(0.037,0.037,0.036)))\*100))  
print(Final\_Proteus\_data)

## Time\_f2 Concentrations Optical\_density  
## 1 0 PenV+Tebipenem (100 ug/mL+10 ug/mL) 7.6923077  
## 2 19 PenV+Tebipenem (100 ug/mL+10 ug/mL) 0.7067138  
## 3 24 PenV+Tebipenem (100 ug/mL+10 ug/mL) 0.6430868  
## 4 41 PenV+Tebipenem (100 ug/mL+10 ug/mL) 0.6833713  
## 5 48 PenV+Tebipenem (100 ug/mL+10 ug/mL) 0.6578947  
## 6 0 PenV+Tebipenem (100 ug/mL+5 ug/mL) 84.6153846  
## 7 19 PenV+Tebipenem (100 ug/mL+5 ug/mL) 4.2402827  
## 8 24 PenV+Tebipenem (100 ug/mL+5 ug/mL) 4.1800643  
## 9 41 PenV+Tebipenem (100 ug/mL+5 ug/mL) 3.4168565  
## 10 48 PenV+Tebipenem (100 ug/mL+5 ug/mL) 2.8508772  
## 11 0 PenV+Tebipenem (50 ug/mL+10 ug/mL) 92.5925926  
## 12 19 PenV+Tebipenem (50 ug/mL+10 ug/mL) 3.6666667  
## 13 24 PenV+Tebipenem (50 ug/mL+10 ug/mL) 3.7037037  
## 14 41 PenV+Tebipenem (50 ug/mL+10 ug/mL) 2.5695931  
## 15 48 PenV+Tebipenem (50 ug/mL+10 ug/mL) 2.4844720  
## 16 0 PenV+Tebipenem (50 ug/mL+5 ug/mL) 92.5925926  
## 17 19 PenV+Tebipenem (50 ug/mL+5 ug/mL) 9.3333333  
## 18 24 PenV+Tebipenem (50 ug/mL+5 ug/mL) 6.1728395  
## 19 41 PenV+Tebipenem (50 ug/mL+5 ug/mL) 3.4261242  
## 20 48 PenV+Tebipenem (50 ug/mL+5 ug/mL) 3.7267081  
## 21 0 PenV+Tebipenem (6.25 ug/mL+10 ug/mL) 92.8571429  
## 22 19 PenV+Tebipenem (6.25 ug/mL+10 ug/mL) 6.7484663  
## 23 24 PenV+Tebipenem (6.25 ug/mL+10 ug/mL) 4.3731778  
## 24 41 PenV+Tebipenem (6.25 ug/mL+10 ug/mL) 3.1578947  
## 25 48 PenV+Tebipenem (6.25 ug/mL+10 ug/mL) 3.0800821  
## 26 0 PenV+Tebipenem (1.5625 ug/mL+10 ug/mL) 92.3076923  
## 27 19 PenV+Tebipenem (1.5625 ug/mL+10 ug/mL) 4.7770701  
## 28 24 PenV+Tebipenem (1.5625 ug/mL+10 ug/mL) 3.6474164  
## 29 41 PenV+Tebipenem (1.5625 ug/mL+10 ug/mL) 3.2397408  
## 30 48 PenV+Tebipenem (1.5625 ug/mL+10 ug/mL) 3.1712474

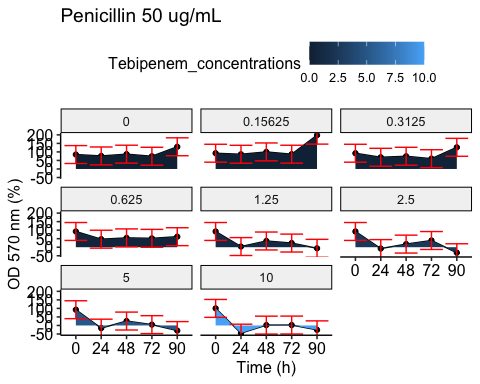
#Make up a line graph   
Final\_Prot <- Final\_Proteus\_data %>%  
 ggplot(aes(x=Time\_f2, y=Optical\_density,group=Concentrations, shape=Concentrations))+  
 geom\_line()+  
 geom\_point()+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Final\_Proteus\_data$Optical\_density-sd(Final\_Proteus\_data$Optical\_density),  
 ymax=Final\_Proteus\_data$Optical\_density+sd(Final\_Proteus\_data$Optical\_density),  
 width=.2)+  
 stat\_compare\_means(method = "kruskal.test", label.y =127)+  
 stat\_compare\_means(label = "p.signif", label.y = c(100,100,100,100,100), label.x = 10)+  
 geom\_hline(yintercept = 0, linetype="dashed", col="grey")  
print(Final\_Prot)



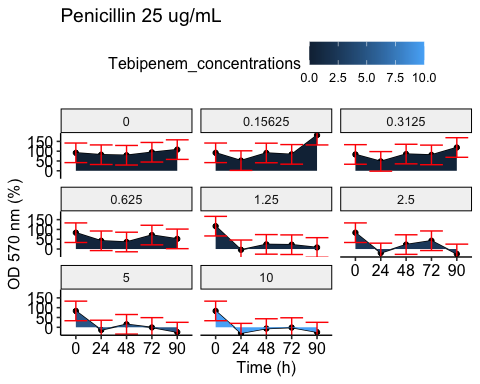
#Mycobacterium smegmatis RESULTS AND PLOTS  
#Penicillin 100 ug/ml   
Mycobacterium\_smegmatis\_100ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.047,0.053,0.049)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.047,0.051,0.047)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.047,0.046,0.046)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.047,0.047,0.047)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.048,0.045,0.045)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.046,0.045,0.045)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.046,0.044,0.046)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.046,0.044,0.046)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.057,0.064,0.047)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.067,0.076,0.101)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.078,0.075,0.126)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.086,0.114,0.125)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.118,0.103,0.146)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.123,0.144,0.138)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.109,0.106,0.152)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.135,0.12,0.163)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.049,0.044,0.08)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.1,0.065,0.119)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.093,0.068,0.084)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.105,0.226,0.182)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.224,0.138,0.183)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.217,0.263,0.163)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.214,0.174,0.237)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.226,0.201,0.25)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.049,0.058,0.043)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.048,0.044,0.128)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.136,0.066,0.048)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.126,0.32,0.153)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.252,0.187,0.302)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.249,0.368,0.209)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.341,0.292,0.315)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.293,0.326,0.34)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.044,0.045,0.041)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.044,0.046,0.14)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.052,0.088,0.083)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.115,0.587,0.137)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.276,0.245,0.373)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.289,0.44,0.281)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.638,0.462,0.637)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,  
 ((mean(0.388,0.418,0.498)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp1 <- Mycobacterium\_smegmatis\_100ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 100 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_100ug\_data $Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_100ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_100ug\_data $Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_100ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp1)



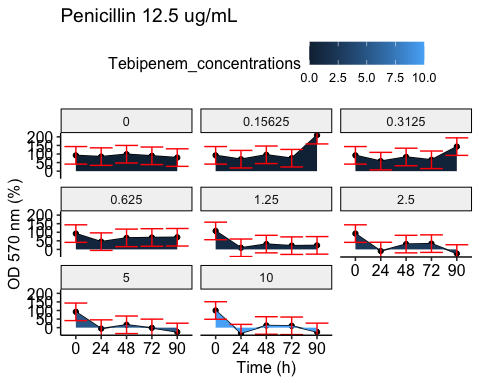
#Penicillin 50 ug/mL   
Mycobacterium\_smegmatis\_50ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.049,0.05,0.049)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.048,0.064)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.047,0.051)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.047,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.046,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.046,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.048,0.047,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.047,0.047,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.067,0.074,0.056)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.082,0.082,0.059)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.086,0.085,0.108)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.092,0.101,0.146)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.114,0.106,0.153)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.125,0.106,0.153)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.134,0.114,0.162)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.129,0.142,0.175)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.053,0.049,0.072)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.1,0.063,0.088)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.085,0.09,0.093)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.121,0.151,0.175)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.157,0.159,0.201)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.196,0.169,0.164)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.246,0.201,0.219)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.22,0.253,0.273)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.057,0.051,0.053)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.065,0.048,0.046)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.178,0.074,0.054)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.129,0.217,0.193)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.22,0.209,0.278)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.247,0.291,0.229)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.333,0.299,0.303)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.294,0.354,0.323)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.062,0.061,0.046)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.05,0.066,0.094)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.043,0.043,0.071)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.117,0.207,0.22)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.311,0.272,0.245)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.497,0.427,0.301)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.7,0.498,0.581)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100,  
 ((mean(0.506,0.521,0.543)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp2 <- Mycobacterium\_smegmatis\_50ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 50 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_50ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_50ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_50ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_50ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp2)



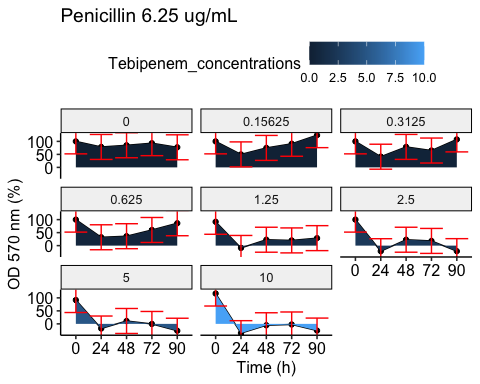
#Penicillin 25 ug/mL   
Mycobacterium\_smegmatis\_25ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.044,0.044,0.044)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.044,0.046,0.045)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.044,0.044,0.043)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.048,0.042,0.043)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.044,0.043,0.044)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.044,0.043,0.042)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.045,0.043,0.044)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.045,0.044,0.043)-mean(0.034,0.034,0.034))/(mean(0.046,0.047,0.044)-mean(0.034,0.034,0.034)))\*100,  
 ((mean(0.071,0.068,0.048)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.079,0.085,0.062)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.076,0.079,0.104)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.084,0.089,0.111)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.107,0.101,0.144)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.11,0.102,0.133)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.112,0.105,0.172)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.127,0.127,0.163)-mean(0.086,0.072,0.045))/(mean(0.136,0.14,0.156)-mean(0.086,0.072,0.045)))\*100,  
 ((mean(0.043,0.042,0.075)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.086,0.053,0.106)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.101,0.091,0.106)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.103,0.147,0.127)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.127,0.144,0.235)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.225,0.187,0.144)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.236,0.181,0.209)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.213,0.228,0.241)-mean(0.056,0.05,0.037))/(mean(0.254,0.229,0.227)-mean(0.056,0.05,0.037)))\*100,  
 ((mean(0.051,0.052,0.049)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.053,0.04,0.044)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.164,0.041,0.054)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.112,0.251,0.14)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.239,0.187,0.311)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.264,0.284,0.188)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.271,0.297,0.256)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.299,0.302,0.302)-mean(0.055,0.054,0.042))/(mean(0.313,0.338,0.352)-mean(0.055,0.054,0.042)))\*100,  
 ((mean(0.041,0.046,0.05)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.041,0.079,0.059)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.04,0.04,0.057)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.147,0.243,0.165)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.289,0.294,0.677)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.506,0.455,0.358)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.71,0.486,0.542)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100,  
 ((mean(0.471,0.468,0.603)-mean(0.121,0.105,0.058))/(mean(0.445,0.424,0.581)-mean(0.121,0.105,0.058)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp3 <- Mycobacterium\_smegmatis\_25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_25ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_25ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_25ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_25ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp3)



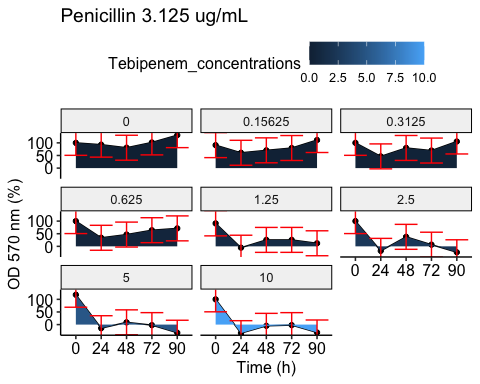
#Penicillin 12.5 ug/mL   
Mycobacterium\_smegmatis\_12.5ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.049,0.05,0.047)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.048,0.048)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.047,0.048)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.05,0.046,0.049)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.046,0.048)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.048,0.047)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.046,0.047)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.048,0.047,0.047)-mean(0.036,0.036,0.036))/(mean(0.049,0.049,0.048)-mean(0.036,0.036,0.036)))\*100,  
 ((mean(0.071,0.072,0.053)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.085,0.081,0.063)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.083,0.08,0.122)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.093,0.088,0.125)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.112,0.105,0.153)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.119,0.114,0.135)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.125,0.119,0.16)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.133,0.129,0.165)-mean(0.088,0.081,0.045))/(mean(0.141,0.141,0.188)-mean(0.088,0.081,0.045)))\*100,  
 ((mean(0.076,0.055,0.082)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.083,0.056,0.119)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.108,0.107,0.119)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.108,0.13,0.147)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.171,0.178,0.148)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.198,0.221,0.157)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.22,0.198,0.213)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.226,0.231,0.247)-mean(0.054,0.063,0.038))/(mean(0.228,0.228,0.27)-mean(0.054,0.063,0.038)))\*100,  
 ((mean(0.083,0.05,0.048)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.049,0.044,0.052)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.147,0.048,0.065)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.114,0.172,0.147)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.247,0.293,0.258)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.238,0.34,0.222)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.264,0.316,0.266)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.303,0.3,0.397)-mean(0.053,0.063,0.04))/(mean(0.332,0.311,0.375)-mean(0.053,0.063,0.04)))\*100,  
 ((mean(0.046,0.061,0.048)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.045,0.05,0.057)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.049,0.08,0.048)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.202,0.19,0.155)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.354,0.304,0.433)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.587,0.504,0.291)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.802,0.45,0.489)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100,  
 ((mean(0.381,0.484,0.508)-mean(0.126,0.117,0.057))/(mean(0.448,0.376,0.466)-mean(0.126,0.117,0.057)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp4 <- Mycobacterium\_smegmatis\_12.5ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 12.5 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_12.5ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_12.5ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_12.5ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_12.5ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp4)



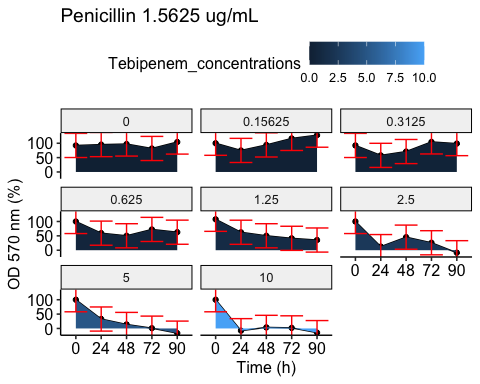
#Penicillin 6.25 ug/mL   
Mycobacterium\_smegmatis\_6.25ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.049,0.048,0.047)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.046,0.047,0.046)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.047,0.045,0.045)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.046,0.046,0.045)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.047,0.046,0.045)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.047,0.045,0.045)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.047,0.045,0.046)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.047,0.046,0.048)-mean(0.035,0.035,0.035))/(mean(0.047,0.048,0.047)-mean(0.035,0.035,0.035)))\*100,  
 ((mean(0.073,0.071,0.046)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.083,0.078,0.067)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.081,0.081,0.114)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.088,0.091,0.138)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.111,0.114,0.149)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.116,0.118,0.138)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.121,0.121,0.147)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.137,0.143,0.204)-mean(0.093,0.078,0.047))/(mean(0.149,0.15,0.181)-mean(0.093,0.078,0.047)))\*100,  
 ((mean(0.05,0.048,0.077)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.084,0.085,0.1)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.108,0.104,0.143)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.108,0.134,0.153)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.136,0.179,0.16)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.224,0.199,0.149)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.216,0.221,0.201)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.237,0.256,0.275)-mean(0.061,0.055,0.036))/(mean(0.268,0.25,0.254)-mean(0.061,0.055,0.036)))\*100,  
 ((mean(0.051,0.047,0.05)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.057,0.039,0.046)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.113,0.051,0.085)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.119,0.215,0.144)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.241,0.279,0.294)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.255,0.306,0.259)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.334,0.355,0.275)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.341,0.304,0.342)-mean(0.058,0.057,0.04))/(mean(0.362,0.338,0.315)-mean(0.058,0.057,0.04)))\*100,  
 ((mean(0.045,0.044,0.054)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.043,0.044,0.05)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.06,0.132,0.044)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.225,0.135,0.198)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.414,0.364,0.278)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.485,0.542,0.309)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.539,0.499,0.383)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100,  
 ((mean(0.385,0.458,0.497)-mean(0.13,0.116,0.061))/(mean(0.46,0.583,0.559)-mean(0.13,0.116,0.061)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp5 <- Mycobacterium\_smegmatis\_6.25ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 6.25 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_6.25ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_6.25ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_6.25ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_6.25ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp5)



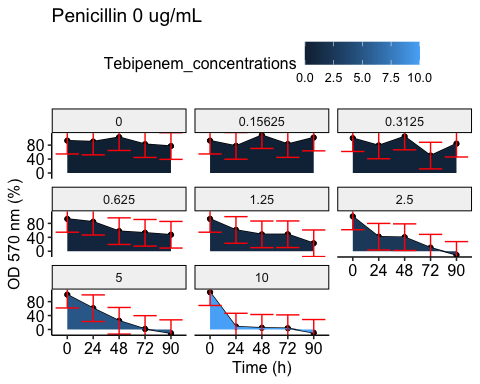
#Penicillin 3.125 ug/mL   
Mycobacterium\_smegmatis\_3.125ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.047,0.049,0.047)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.049,0.046,0.046)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.047,0.045,0.046)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.046,0.045,0.046)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.047,0.047,0.045)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.047,0.046,0.045)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.046,0.045,0.045)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.047,0.046,0.046)-mean(0.036,0.035,0.035))/(mean(0.047,0.052,0.046)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.078,0.088,0.045)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.089,0.111,0.06)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.087,0.085,0.099)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.094,0.094,0.129)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.116,0.108,0.156)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.123,0.116,0.152)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.131,0.12,0.167)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.149,0.153,0.187)-mean(0.097,0.08,0.046))/(mean(0.153,0.171,0.189)-mean(0.097,0.08,0.046)))\*100,  
 ((mean(0.046,0.05,0.054)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.077,0.052,0.123)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.141,0.077,0.145)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.114,0.172,0.142)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.161,0.186,0.17)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.235,0.203,0.168)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.214,0.205,0.224)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.237,0.266,0.276)-mean(0.057,0.05,0.039))/(mean(0.28,0.269,0.268)-mean(0.057,0.05,0.039)))\*100,  
 ((mean(0.046,0.047,0.047)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.046,0.042,0.057)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.071,0.041,0.058)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.126,0.198,0.149)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.237,0.252,0.27)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.253,0.369,0.216)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.282,0.278,0.293)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.346,0.322,0.316)-mean(0.052,0.048,0.039))/(mean(0.341,0.348,0.436)-mean(0.052,0.048,0.039)))\*100,  
 ((mean(0.045,0.044,0.05)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.042,0.044,0.044)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.068,0.05,0.043)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.173,0.186,0.225)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.347,0.316,0.338)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.448,0.411,0.326)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.465,0.319,0.348)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100,  
 ((mean(0.522,0.592,0.428)-mean(0.137,0.118,0.061))/(mean(0.432,0.54,0.618)-mean(0.137,0.118,0.061)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp6 <- Mycobacterium\_smegmatis\_3.125ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 3.125 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_3.125ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_3.125ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_3.125ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_3.125ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp6)



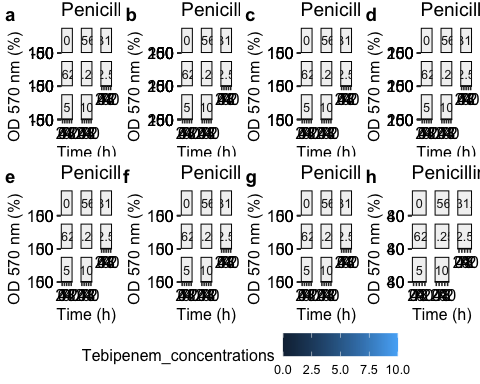
#Penicillin 1.5625 ug/mL   
Mycobacterium\_smegmatis\_1.5625ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.047,0.049,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.047,0.047,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.047,0.047,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.048,0.045,0.047)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.047,0.047,0.047)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.046,0.045,0.045)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.047,0.045,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.046,0.045,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.068,0.07,0.056)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.094,0.084,0.052)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.081,0.081,0.126)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.113,0.094,0.119)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.111,0.111,0.156)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.11,0.139,0.145)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.121,0.12,0.165)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.134,0.153,0.181)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.053,0.048,0.059)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.072,0.05,0.101)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.131,0.105,0.143)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.14,0.165,0.128)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.14,0.201,0.177)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.179,0.216,0.161)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.222,0.222,0.224)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.228,0.258,0.286)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.047,0.049,0.048)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.044,0.042,0.043)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.118,0.044,0.048)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.164,0.209,0.121)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.256,0.271,0.383)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.352,0.296,0.247)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.388,0.281,0.28)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.284,0.284,0.331)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.05,0.045,0.045)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.044,0.043,0.044)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.069,0.042,0.066)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.215,0.219,0.262)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.305,0.322,0.537)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.424,0.465,0.299)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.521,0.322,0.4)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100,  
 ((mean(0.442,0.349,0.383)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp7 <- Mycobacterium\_smegmatis\_1.5625ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 1.5625 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_1.5625ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_1.5625ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_1.5625ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_1.5625ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp7)



#Penicillin 0 ug/mL   
Mycobacterium\_smegmatis\_0ug\_data <- data.frame(Time= c(rep("0",8),rep("24",8),rep("48",8),rep("72",8),rep("90",8)),  
 Tebipenem\_concentrations=c(10.0,5.0,2.5,1.25,0.625,0.3125,0.15625,0),  
 Optical\_density\_mean\_values =c(((mean(0.05,0.052,0.051)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.049,0.051,0.049)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.049,0.049,0.049)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.048,0.048,0.049)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.048,0.047,0.048)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.049,0.048,0.048)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.048,0.046,0.047)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.048,0.048,0.048)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.07,0.084,0.047)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.108,0.098,0.047)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.094,0.093,0.091)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.108,0.109,0.136)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.125,0.118,0.198)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.121,0.144,0.16)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.12,0.127,0.175)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.129,0.152,0.209)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.051,0.052,0.07)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.093,0.046,0.051)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.125,0.064,0.152)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.142,0.178,0.155)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.161,0.179,0.279)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.259,0.244,0.181)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.267,0.229,0.249)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.255,0.277,0.286)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.053,0.048,0.045)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.044,0.065,0.05)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.079,0.042,0.084)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.234,0.062,0.134)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.251,0.287,0.362)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.239,0.391,0.33)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.372,0.238,0.303)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.371,0.315,0.392)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.048,0.049,0.052)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.044,0.047,0.046)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.044,0.042,0.07)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.19,0.183,0.296)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.297,0.297,0.466)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.458,0.447,0.395)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.535,0.454,0.482)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100,  
 ((mean(0.428,0.521,0.461)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100))  
#Make a line graphs for changing in OD with time according to Tebipenem concentrations  
Mp8 <- Mycobacterium\_smegmatis\_0ug\_data %>%  
 ggplot(aes(x=Time,y=Optical\_density\_mean\_values,group=Tebipenem\_concentrations, fill=Tebipenem\_concentrations))+  
 geom\_line()+  
 geom\_point()+  
 geom\_area() +  
 facet\_wrap(~Tebipenem\_concentrations)+  
 ggtitle("Penicillin 0 ug/mL")+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Mycobacterium\_smegmatis\_0ug\_data$Optical\_density\_mean\_values-sd(Mycobacterium\_smegmatis\_0ug\_data$Optical\_density\_mean\_values),  
 ymax=Mycobacterium\_smegmatis\_0ug\_data$Optical\_density\_mean\_values+sd(Mycobacterium\_smegmatis\_0ug\_data$Optical\_density\_mean\_values), col="red")  
print(Mp8)



#Align all graphs together   
library(ggplot2)  
library(ggpubr)  
theme\_set(theme\_pubr())  
figure\_3 <- ggarrange(Mp1,Mp2,Mp3,Mp4, Mp5, Mp6, Mp7, Mp8,  
 labels=c("a","b","c","d","e","f","g","h"),  
 ncol=4,nrow=2,  
 common.legend = TRUE,legend = "bottom")  
print(figure\_3)



#Compare concentrations that inhibt the bacterial growth   
Final\_Myco\_data <- data.frame(Time\_f3 =c("0","24","48","72","96"),  
 Concentrations= c(rep("PenicillinV 100 ug/mL + Tebip 1.25 ug/mL",5),  
 rep("PenicillinV 50 ug/mL + Tebip 1.25 ug/mL",5),  
 rep("PenicillinV 1.5625 ug/mL + Tebip 2.5 ug/mL",5),  
 rep("PeenicillinV 0 ug/mL + Tebip 2.5 ug/mL",5)),  
 Optical\_density\_value=c(((mean(0.047,0.047,0.047)-mean(0.036,0.036,0.037))/(mean(0.05,0.051,0.053)-mean(0.036,0.036,0.037)))\*100,  
 ((mean(0.086,0.114,0.125)-mean(0.08,0.065,0.04))/(mean(0.135,0.135,0.162)-mean(0.08,0.065,0.04)))\*100,  
 ((mean(0.105,0.226,0.182)-mean(0.052,0.047,0.038))/(mean(0.237,0.25,0.27)-mean(0.052,0.047,0.038)))\*100,  
 ((mean(0.126,0.32,0.153)-mean(0.047,0.049,0.041))/(mean(0.363,0.42,0.358)-mean(0.047,0.049,0.041)))\*100,  
 ((mean(0.115,0.587,0.137)-mean(0.119,0.097,0.048))/(mean(0.444,0.576,0.536)-mean(0.119,0.097,0.048)))\*100,# end of 100+1.25  
 ((mean(0.048,0.047,0.047)-mean(0.036,0.035,0.035))/(mean(0.049,0.05,0.047)-mean(0.036,0.035,0.035)))\*100,  
 ((mean(0.092,0.101,0.146)-mean(0.09,0.075,0.041))/(mean(0.141,0.143,0.156)-mean(0.09,0.075,0.041)))\*100,  
 ((mean(0.121,0.151,0.175)-mean(0.049,0.046,0.038))/(mean(0.246,0.235,0.246)-mean(0.049,0.046,0.038)))\*100,  
 ((mean(0.129,0.217,0.193)-mean(0.049,0.05,0.04))/(mean(0.377,0.364,0.494)-mean(0.049,0.05,0.04)))\*100,  
 ((mean(0.117,0.207,0.22)-mean(0.135,0.118,0.057))/(mean(0.42,0.432,0.609)-mean(0.135,0.118,0.057)))\*100, #end of 50+1.25  
 ((mean(0.047,0.047,0.046)-mean(0.034,0.034,0.039))/(mean(0.047,0.052,0.046)-mean(0.034,0.034,0.039)))\*100,  
 ((mean(0.081,0.081,0.126)-mean(0.073,0.061,0.04))/(mean(0.137,0.181,0.182)-mean(0.073,0.061,0.04)))\*100,  
 ((mean(0.131,0.105,0.143)-mean(0.046,0.043,0.037))/(mean(0.233,0.282,0.261)-mean(0.046,0.043,0.037)))\*100,  
 ((mean(0.118,0.044,0.048)-mean(0.041,0.04,0.037))/(mean(0.338,0.307,0.386)-mean(0.041,0.04,0.037)))\*100,  
 ((mean(0.069,0.042,0.066)-mean(0.098,0.084,0.047))/(mean(0.428,0.38,0.71)-mean(0.098,0.084,0.047)))\*100, #end of 1.5625+2.5  
 ((mean(0.049,0.049,0.049)-mean(0.035,0.035,0.034))/(mean(0.049,0.052,0.049)-mean(0.035,0.035,0.034)))\*100,  
 ((mean(0.094,0.093,0.091)-mean(0.064,0.053,0.038))/(mean(0.136,0.17,0.214)-mean(0.064,0.053,0.038)))\*100,  
 ((mean(0.125,0.064,0.152)-mean(0.041,0.039,0.037))/(mean(0.249,0.29,0.281)-mean(0.041,0.039,0.037)))\*100,  
 ((mean(0.079,0.042,0.084)-mean(0.038,0.038,0.037))/(mean(0.44,0.37,0.338)-mean(0.038,0.038,0.037)))\*100,  
 ((mean(0.044,0.042,0.07)-mean(0.09,0.08,0.044))/(mean(0.527,0.577,0.646)-mean(0.09,0.08,0.044)))\*100)) #end of 0+2.5   
#Make up a line graph   
Final\_Myco<- Final\_Myco\_data %>%  
 ggplot(aes(x=Time\_f3, y=Optical\_density\_value,group=Concentrations, shape=Concentrations))+  
 geom\_line()+  
 geom\_point(size=2)+  
 xlab("Time (h)")+  
 ylab("OD 570 nm (%)")+  
 geom\_errorbar(ymin=Final\_Myco\_data$Optical\_density\_value-sd(Final\_Myco\_data$Optical\_density\_value),  
 ymax=Final\_Myco\_data$Optical\_density\_value+sd(Final\_Myco\_data$Optical\_density\_value),  
 width=.2)+  
 stat\_compare\_means(method = "kruskal.test", label.y =140)+  
 stat\_compare\_means(label = "p.signif", label.y = c(110,100,90,70,50))+  
 geom\_hline(yintercept = 0, linetype="dashed", col="grey")  
print(Final\_Myco)

