Appendix  SELF-TEST Mathematical background

For each of questions 1-4, which of the mathematical statements is correct?

1.
- A. \( \frac{1}{3} + \frac{1}{4} = \frac{1}{12} \)
- B. \( \frac{1}{3} + \frac{1}{4} = \frac{1}{7} \)
- C. \( \frac{1}{3} - \frac{1}{4} = \frac{1}{12} \)
- D. \( \frac{1}{3} + \frac{1}{4} = \frac{5}{12} \)

2.
- A. \( \log(2) + \log(3) = \log(5) \)
- B. \( \log(8) = 3\log(2) \)
- C. \( \log(8) = 8\log(1) \)
- D. \( \log(2) + \log(3) = \log(8) \)

3.
- A. \( 2^{10} + 4^{10} = 6^{10} \)
- B. \( 2^{10} + 2^{6} = 2^{16} \)
- C. \( 3 \times 2^{10} = 2^{30} \)
- D. \( 8 \times 2^{10} = 2^{13} \)

4.
- A. \( \sum_{n=4}^{8} n^2 = \sum_{n=1}^{8} n^2 - \sum_{n=3}^{8} n^2 \)
- B. \( \sum_{n=4}^{8} n^2 = \sum_{n=1}^{8} n^2 - \sum_{n=1}^{3} n^2 \)
- C. \( \sum_{n=1}^{8} n^2 = \frac{n(n + 1)(2n + 1)}{6} \)
5. In a class of 20 students, the teacher asks for two volunteers. How many different ways can the 2 volunteers be chosen?
   - A. $2^{20}$
   - B. $20 \times 19$
   - C. $20 \times 19 / 2$
   - D. 20!

6. The class of 20 students is having a games lesson. How many different ways can the class be divided into 2 teams of 10?
   - A. 20!
   - B. $10! + 10!$
   - C. $20! / (10! \times 10!)$
   - D. $20! / (2 \times 10! \times 10!)$

7. The value of the definite integral $\int_{4}^{5} 2x \, dx$ is
   - A. 9
   - B. 5
   - C. 2
   - D. 1

8. Which of the functions $f(x)$ is a solution of the following differential equation?
   \[
   \frac{df}{dx} = 2f - 1
   \]
   - A. $f(x) = \frac{1}{2}(e^{2x} + 1)$
   - B. $f(x) = \frac{1}{2}e^{2x} + 1$
9. A solution contains many RNA oligomers of length 6 bases. All 4 bases are present with equal frequency and are present in random orders in the oligomers. The proportion of oligomers containing exactly 2 guanines should be approximately:

- A. 0.2966
- B. 0.0625
- C. 0.0198
- D. 0.000244

10. A DNA sequence of length 100 nucleotides is generated randomly such that each of the 4 bases A, C, G and T is chosen with equal frequency. The base at each position is chosen independently of the others. Let $P(n)$ be the probability that there are $n$ Gs in the sequence. Which of the following statements is correct?

- A. $P(n)$ can be approximated by a Normal distribution with mean 20 and variance 75.
- B. $P(n)$ can be approximated by a Normal distribution with mean 25 and variance 18.75.
- C. $P(n)$ can be approximated by a Poisson distribution with mean 25 and variance 25.
- D. $P(n)$ is a bell-shaped curve with a peak at $n = 50$. 

- C. $f(x) = e^{x^2 + 1/2}$
- D. $f(x) = e^{x^2 + 1/2}$
11. A DNA sequence of length 100 is obtained from a real sequence database. The numbers of the 4 different bases are:
   \[ A = 20; \quad C = 27; \quad G = 34; \quad T = 19. \]

The 5% significance values in the $\chi^2$ Table are

<table>
<thead>
<tr>
<th>number of degrees of freedom</th>
<th>5% significance value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.84</td>
</tr>
<tr>
<td>2</td>
<td>5.99</td>
</tr>
<tr>
<td>3</td>
<td>7.82</td>
</tr>
<tr>
<td>4</td>
<td>9.49</td>
</tr>
</tbody>
</table>

- A. The $\chi^2$ test shows that the content of G+C bases differs significantly from 50%.
- B. The $\chi^2$ test shows that the content of G+C bases does not differ significantly from 50%.
- C. More information is needed to carry out a $\chi^2$ test.
- D. A $\chi^2$ test is not valid in this case.

12. A student answers a multiple choice exam paper with 12 questions on it. He guesses randomly from the 4 possible answers on each question. Which of the following is true?

- A. The probability of guessing all 12 questions correctly is slightly greater than 3%.
- B. The probability of getting exactly 3 correct answers is 0.0156.
- C. The probability of getting exactly 3 correct answers is $1.17 \times 10^{-3}$.
- D. The probability of guessing all answers wrong is greater than the probability of guessing all answers right.