Question 1
Part A

```
The matrix for global alignment :
X     _     G     A     T     G     C     G     C     A     G
_     0    -1    -2    -3    -4    -5    -6    -7    -8    -9
G    -1     2     1     0    -1    -2    -3    -4    -5    -6
G    -2     1     0    -1     2     1     0    -1    -2    -3
C    -3     0    -1    -2     1     4     3     2     1     0
A    -4    -1     2     1     0     3     2     1     4     3
G    -5    -2     1     0     3     2     5     4     3     6
T    -6    -3     0     3     2     1     4     3     2     5
A    -7    -4    -1     2     1     0     3     2     5     4
```

Part B

Yes, there is more than one possibility of optimally aligning the given sequences.

Part C

```
All the optimal alignments with their scores:
GATGCGCAG--
---G-GCAGTA
Score is: 4
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GATGCGCAG--
G----GCAGTA
Score is: 4
------------------------------

GATGCGCAG--
G--G--CAGTA
Score is: 4
------------------------------

GATGCGCAG--
G--GC--AGTA
Score is: 4
------------------------------

GATGC-GC-AG
```

```
G--GCAG-TA-
Score is: 4
------------------------------
```

```
GATGC-G-CAG
G--GCAGT-A-
Score is: 4
------------------------------
```

Question 2

Yes, changing the scoring scheme does modify the result of the above questions.
The new results we get are:

a)
```
The matrix for global alignment:
```

X	_	G	A	T	G	C	G	C	A	G
_	0	-3	-6	-9	-12	-15	-18	-21	-24	-27
G	-3	2	-1	-4	-7	-10	-13	-16	-19	-22
G	-6	-1	1	-2	-2	-5	-8	-11	-14	-17
C	-9	-4	-2	0	-3	0	-3	-6	-9	-12
A	-12	-7	-2	-3	-1	-3	-1	-4	-4	-7
G	-15	-10	-5	-3	-1	-2	-1	-2	-5	-2
T	-18	-13	-8	-3	-4	-2	-3	-2	-3	-5
A	-21	-16	-11	-6	-4	-5	-3	-4	0	-3

b) No, there is only one possibility of optimally aligning the given sequence.

c)
```
All the optimal alignments with their scores:
GATGC-GCAG
G--GCAGTA-
Score is: -3
------------------------------
```

- Here we can see as we changed the scoring scheme, the values of the matrix got changed such that it got filled according to the new scheme.
- we got a different alignment with one less gap because we are giving more penalties to gaps.
- we are getting a negative score with only one optimal alignment, and this is because of more negative penalties for gaps.

Hence, the alignments and scores changed because we gave more penalties for inserting a gap as compared to a mismatch. So our matrix stored answers that were best for this scoring scheme.

Question 3
Part A

The matrix for local alignment:

X	_	G	A	T	G	C	G	C	A	G
_	0	0	0	0	0	0	0	0	0	0
G	0	2	0	0	2	0	2	0	0	2
G	0	2	1	0	2	1	2	1	0	2
C	0	0	1	0	0	4	1	4	1	0
A	0	0	2	0	0	1	3	1	6	3
G	0	2	0	1	2	0	3	2	3	8
T	0	0	1	2	0	1	0	2	1	5
A	0	0	2	0	1	0	0	0	4	2

Part B

```
All the optimal alignments with their scores:
GCAG
GCAG
Score is: 8
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```

Question 4

The following changes were required to do local rather than global alignment:
- Initialization of the 0th row and 0th column in local should be filled with zeroes instead of initializing with gap penalties like in global alignment.
- Filling of the matrix: The minimum value in the local matrix is 0. Hence while filling the matrix, if we get a negative value, in that case, we simply fill with 0 instead of it.
- To trace back a matrix: Instead of starting from the last cell of the matrix like in global alignment, we find the cells with the maximum value and then start backtracking from there.
- The base case for backtracking in the case of local alignment is when we reach a cell with a value of 0, whereas, in the case of global alignment, the base case is when we reach the matrix end, i.e., at (0,0) cell.