**Supplemental tables**

**Table S1.** The role of cumulus cells and their gap junctions in oocyte maturation (n=3).

|  |  |  |
| --- | --- | --- |
| Maturation | Abbreviation | PB1 % (mean ± SD) |
| *In vivo* OCC | M-vivo-OCC | 98.78 ± 0.22a |
| *In vitro* OCC | M-vitro-OCC | 97.57 ± 0.59a |
| *In vitro* DO + cumulus | M-vitro-DC | 86.23 ± 4.05b |
| *In vitro* DO | M-vitro-DO | 81.56 ± 6.48b |

a,bValues with different superscripts within each column are significantly different (*P*< 0.05).

**Table S2.** Fertilization based on the number of GV oocytes (n=3).

|  |  |  |  |
| --- | --- | --- | --- |
| Maturation | Insemination | Abbreviation | 2-cell % (mean ± SD) |
| *In vivo* OCC | OCC | M-vivo-OCC + I-OCC | 91.68 ± 1.63a |
| DO + cumulus | M-vivo-OCC + I-DC | 80.65 ± 2.32b |
| DO | M-vivo-OCC + I-DO | 64.34 ± 2.30c |
| *In vitro* OCC | OCC | M-vitro-OCC + I-OCC | 53.02 ± 8.00d |
| DO + cumulus | M-vitro-OCC + I-DC | 55.72 ± 2.71d |
| DO | M-vitro-OCC + I-DO | 45.62 ± 5.74e |
| *In vitro* DO + cumulus | DO + cumulus | M-vitro-DC + I-DC | 46.62 ± 6.07e |
| DO | M-vitro-DC + I-DO | 37.30 ± 2.50f |
| *In vitro* DO | DO + cumulus | M-vitro-DO + I-DC | 47.15 ± 4.47e |
| DO | M-vitro-DO + I-DO | 36.93 ± 5.29f |

a-fValues with different superscripts within each column are significantly different (*P*< 0.05).

**Table S3.** Fertilization based on the number of MII oocytes (n=3).

|  |  |  |  |
| --- | --- | --- | --- |
| Maturation | Insemination | Abbreviation | 2-cell % (mean ± SD) |
| *In vivo* OCC | OCC | M-vivo-OCC + I-OCC | 92.86 ± 1.60a |
| DO + cumulus | M-vivo-OCC + I-DC | 82.04 ± 2.06b |
| DO | M-vivo-OCC + I-DO | 65.37 ± 2.60c |
| *In vitro* OCC | OCC | M-vitro-OCC + I-OCC | 54.43 ± 7.94d |
| DO + cumulus | M-vitro-OCC + I-DC | 56.75 ± 3.55d |
| DO | M-vitro-OCC + I-DO | 46.39 ± 5.74e |
| *In vitro* DO + cumulus | DO + cumulus | M-vitro-DC + I-DC | 53.98 ± 4.42d |
| DO | M-vitro-DC + I-DO | 43.50 ± 4.48e |
| *In vitro* DO | DO + cumulus | M-vitro-DO + I-DC | 57.95 ± 4.38d |
| DO | M-vitro-DO + I-DO | 45.77 ± 6.48e |

a-eValues with different superscripts within each column are significantly different (*P*< 0.05).

**Table S4.** Embryonic development based on the number of GV oocytes (n=3).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Maturation | Insemination | Abbreviation | 4-cell %  (mean ± SD) | Morula %  (mean ± SD) | Blastocyst %  (mean ± SD) |
| *In vivo* OCC | OCC | M-vivo-OCC + I-OCC | 79.03 ± 4.73a | 74.39 ± 2.48a | 52.61 ± 6.08a |
| DO + cumulus | M-vivo-OCC + I-DC | 62.38 ± 13.71b | 52.26 ± 9.30b | 36.01 ± 4.65b |
| DO | M-vivo-OCC + I-DO | 27.47 ± 4.62c | 22.55 ± 5.81c | 15.30 ± 8.34c |
| *In vitro* OCC | OCC | M-vitro-OCC + I-OCC | 21.72 ± 2.51d | 17.26 ± 0.59d | 7.66 ± 0.92d |
| DO + cumulus | M-vitro-OCC + I-DC | 19.64 ± 4.89d | 15.22 ± 1.89de | 10.55 ± 1.18d |
| DO | M-vitro-OCC + I-DO | 16.77 ± 2.03d | 14.71 ± 1.32de | 7.90 ± 2.02d |
| *In vitro*  DO + cumulus | DO + cumulus | M-vitro-DC + I-DC | 18.01 ± 2.04d | 14.41 ± 3.31df | 6.22 ± 3.40d |
| DO | M-vitro-DC + I-DO | 18.87 ± 1.58d | 14.45 ± 1.50df | 8.20 ± 0.92d |
| *In vitro* DO | DO + cumulus | M-vitro-DO + I-DC | 17.16 ± 1.84d | 12.03 ± 1.87ef | 5.83 ± 0.69d |
| DO | M-vitro-DO + I-DO | 11.90 ± 1.27e | 10.41 ± 0.74f | 5.97 ± 0.64d |

a-fValues with different superscripts within each column are significantly different (*P*< 0.05).

**Table S5.** Embryonic development based on the number of MII oocytes (n=3).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Maturation | Insemination | Abbreviation | 4-cell %  (mean ± SD) | Morula %  (mean ± SD) | Blastocyst %  (mean ± SD) |
| *In vivo* OCC | OCC | M-vivo-OCC + I-OCC | 80.06 ± 4.97a | 75.35 ± 2.69a | 53.29 ± 6.16a |
| DO + cumulus | M-vivo-OCC + I-DC | 63.42 ± 13.69b | 53.14 ± 9.25b | 36.65 ± 4.85b |
| DO | M-vivo-OCC + I-DO | 27.92 ± 4.84c | 22.93 ± 6.03c | 15.57 ± 8.56c |
| *In vitro* OCC | OCC | M-vitro-OCC + I-OCC | 22.32 ± 2.68d | 17.73 ± 0.59d | 7.88 ± 0.99d |
| DO + cumulus | M-vitro-OCC + I-DC | 19.98 ± 3.35d | 15.49 ± 1.19d | 10.77 ± 2.77d |
| DO | M-vitro-OCC + I-DO | 17.04 ± 1.84de | 14.95 ± 1.20d | 8.05 ± 2.12d |
| *In vitro*  DO + cumulus | DO + cumulus | M-vitro-DC + I-DC | 20.93 ± 2.46d | 16.80 ± 4.30d | 7.33 ± 4.18d |
| DO | M-vitro-DC + I-DO | 21.96 ± 1.98d | 16.78 ± 1.14d | 9.57 ± 1.41d |
| *In vitro* DO | DO + cumulus | M-vitro-DO + I-DC | 21.03 ± 0.65d | 14.83 ± 2.46d | 7.21 ± 1.28d |
| DO | M-vitro-DO + I-DO | 14.72 ± 0.90e | 12.95 ± 1.53d | 7.41 ± 0.85d |

a-eValues with different superscripts within each column are significantly different (*P*< 0.05).

**Table S6.** Embryonic development based on number of 2-cell embryos (n=3).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Maturation | Insemination | Abbreviation | 4-cell %  (mean ± SD) | Morula %  (mean ± SD) | Blastocyst %  (mean ± SD) |
| *In vivo* OCC | OCC | M-vivo-OCC + I-OCC | 86.23 ± 5.71a | 86.23 ± 5.71a | 57.32 ± 5.64a |
| DO + cumulus | M-vivo-OCC + I-DC | 77.06 ± 14.54b | 64.62 ± 9.56b | 44.78 ± 6.93b |
| DO | M-vivo-OCC + I-DO | 42.61 ± 6.23cd | 34.95 ± 8.33c | 23.56 ± 12.44c |
| *In vitro* OCC | OCC | M-vitro-OCC + I-OCC | 42.10 ± 11.57de | 33.09 ± 5.40cde | 14.86 ± 4.20d |
| DO + cumulus | M-vitro-OCC + I-DC | 35.42 ± 7.41de | 27.39 ± 3.32de | 18.95 ± 4.67d |
| DO | M-vitro-OCC + I-DO | 36.87 ± 3.13de | 32.38 ± 2.03cde | 17.20 ± 2.82de |
| *In vitro*  DO + cumulus | DO + cumulus | M-vitro-DC + I-DC | 39.05 ± 6.75de | 31.59 ± 10.15cde | 13.99 ± 8.74d |
| DO | M-vitro-DC + I-DO | 50.80 ± 6.17c | 39.03 ± 6.79cd | 21.94 ± 1.28ce |
| *In vitro* DO | DO + cumulus | M-vitro-DO + I-DC | 36.47 ± 3.70e | 25.84 ± 5.71e | 12.52 ± 2.55d |
| DO | M-vitro-DO + I-DO | 32.74 ± 6.15e | 28.76 ± 6.11e | 16.58 ± 4.32de |

a-eValues with different superscripts within each column are significantly different (*P*< 0.05).